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FUTURE INDUSTRIAL OPPORTUNITIES IN CUBA.

By Wilfrid Skaife.

THE coming change in the government of Cuba will naturally attract the attention of the engineering and contracting world to the development of the resources of that country, and the writer desires to point out as briefly as may be some possibilities for a successful exercise of energy and the investment of capital, and, as well, to speak of the darker side of Cuban industrial life.

A great deal of valuable statistical information about Cuba may be gleaned from encyclopedias and foreign consular reports, and much sentimental information of no value from the American dailies.

In the first place, intending settlers and investors will do well, in trying to avail themselves of the undoubted opportunities the island offers, to consider the moral degeneration of the people, who will be slow to learn that honesty and fair dealing are possible in business transactions.

The administration of justice is a perfect farce, and the wholesale open corruption in the custom house is probably unequalled elsewhere. Special commissioners to levy special taxes constantly appear without warning on the scene, being always political friends of the Spanish government officials, and these men are regularly "squared" by the victims to keep quiet or issue false reports. Tricks and schemes to make money dishonestly abound in all walks of life, except perhaps among the ordinary labourers, who are sober, industrious, peaceable individuals enduring mighty hardships at the hands of their infernal government.

This state of affairs will not be cured in a day. Many a

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Spaniard and Cuban bitterly deplores the present abominable *régime*, but the power of the better men is swamped by that of the more unscrupulous. The writer has entire faith in an ultimate bright future for Spain and Cuba, when some western light shall shine through the present darkness and the people have half a chance to educate their children and take some real part in the government of their country; but chaos will surely come first, and industrial pursuits will suffer for a time.

The various directions in which industrial and engineering works may be carried out may be generally stated to be the same as those which present themselves in any new country, in spite of the fact that Cuba is the oldest settlement in America. It is a bitter comment on Spanish rule to point out that common roads for wheeled vehicles hardly exist, except in the near vicinity of the larger towns. What is known as a Camino Real (Royal Road) is merely a broad strip of country, sometimes fenced by cactus and barbed wire, and passable on horseback or by ox-carts in the dry season. The only time, in fact, in which hauling can be done to any extent is during the long dry season, when the field roads made by the sugar and tobacco estates can be traversed by great two-wheeled carts with four oxen. Two days of rain stops traffic in all directions. The opportunity for the building of common roads is larger, and in most places there is plenty of stone for the purpose.

The roads cross rivers, etc., by fords which are impassable soon after the rains set in, and, although the streams are neither large or very numerous, the necessity for bridges is great.

Means of rapid transport exist in the shape of railroads and coasting steamers. The former are fairly well equipped, but are operated only in the daytime and at a rate of speed which is not what other countries are accustomed to to-day. They extend through the western provinces of Pinar del Rio, Havana, Matanzas, and Santa Clara, in various directions, and two short lines extend from the north and south coasts into Puerto Principe. A glance at the map will show that the great bulk of the island to the east of Santa Clara is yet untouched. Part of the region is still unexplored.

On the various sugar estates narrow-gauge roads are in extensive use for the handling of cane, and often form means of communication with the interior in connection with coasting steamers and the broad-gauge roads. These narrow gauge roads are of much greater extent than might be supposed. The large estate called Constostia, for instance, has more than forty miles of such road, and many have more than twenty miles. The handling of cane and its development will be dealt with further on, when the sugar industry is considered.

No electric roads exist in Cuba at the present time, but their immediate institution may be looked for. It is a singular fact that the travel on the various coasting steamers, on the vessels running up the small rivers, on the railroads, and on the few "busses" that run to suburbs of the larger towns, is very much larger than one would expect from the apparent nature of the people and their means. The writer has constantly been surprised at the over-crowding of these means of travel, and understands, on the best of authority, that the business is a very paying one indeed. The rates charged are usually exorbitant, but the travel goes on even when the possibility of being dynamited *en route* adds to the general discomfort.

The writer travelled last winter on a train with pilot engines in front, an armoured car behind, and amid the liveliest rumors of trouble on the road, and, though there were few first-class passengers, the other cars were filled with people travelling. God knows why! The extension and improvement of steam railways, opening up the country and giving better service, is sure to be a very paying business in the future, while there are a number of towns in which electric roads could be run to advantage, besides Havana itself.

Municipal improvements will also give much work in the future to engineers. First among these is the drainage of the towns. The sewers, where any exist, are horrible things, built without the most elementary knowledge, in which the congested filth of years breeds disease and vile odours. Means of flushing them do not exist, and undoubtedly the more apparently filthy system of dumping house refuse, and emptying substitutes for water closets, along the curb stone is less dangerous to health than such a sewerage system. To this abominable condition of the towns may be traced the prevalence of fevers, small pox, and dysentery in Cuba. These diseases are uncommon in the isolated estates, and may, the writer firmly believes, be almost entirely eliminated from the island by giving attention in the towns to the most ordinary rules of sanitation.

Another and equally important necessity in Cuban towns is water. Havana is pretty well supplied, but in most other towns there is very little or none besides the rain water stored during the wet season, in great stone cisterns beneath the houses. It is not that the people in general do not fully appreciate the necessity and luxury of water, but that the executive power is lacking. Taxes are raised for this purpose, and special taxes are sometimes levied to build new works or for coal to keep the pump going, but (and this may serve as instance of many transactions) the money is calmly banked to the credit of the officials, or the coal is bought and resold for their benefit. Water is wanted terribly in the towns during the dry season, and may

easily be had. Excellent springs abound in most places, and small rivers of good water are fairly common.

Connected with the cities and towns may be cited harbour improvements. Cuba is the land of fine harbours. Havana, Matanzas, Santiago, Guantanamo, Cienfuegos, and many other less important spots have splendid harbours, and, with the exception of Matanzas, which is wide at the mouth, the entrances are so narrow that inside they resemble inland lakes in appearance and calmness. But there their usefulness ends, for no piers or wharves worthy of the name exist for sea-going vessels.

Almost all loading and unloading is done by means of lighters. Money indeed is collected for the construction of piers and the dredging of approaches to them, but no work is done, for a very profitable understanding seems to exist between the owners of the lighters and the city governments on these points.

Such a condition of things cannot continue for very long. In a prosperous season Cuba ships a million tons of sugar alone, and surely, under a half-enlightened government, this is worth an occasional pier.

To turn to the great industries of the country,—those that have made Cuba's reputation for wealth, and justly so,—two far outclass the rest,—namely, the production of sugar and of tobacco. Apart from these there is the production of fruit,—mostly bananas,—of coffee, and of iron, that of coffee and of iron being of small extent and confined to the province of Santiago. Incidental to the growth of the sugar industry and the demands of the towns there is the herding of cattle, a considerable and very profitable industry in times of peace.

What the iron and copper deposits may amount to it is now impossible to say, but that both exist in paying quantities is undoubted.

Two considerable iron deposits are now being worked successfully, close to the town of Santiago, by American companies; one other, the Signa M. Co., was started on a large scale, but abandoned soon, as the ore was on the surface only.

Copper mines in the coast range near Santiago were worked some years ago, but, the writer understands, were choked to death by excessive and special taxation.

In the total absence of any official reports on which the smallest reliance can be placed, the prospecting engineer must attack the problem of Cuban mining for the future from the very beginning. All one can say at present is that the field is a promising one. The ore deposits lie near the coast, and the large shipments of iron ore, even in these troubled times, attest its value in the eyes of American buyers.

However, the mining industries will be confined to the mountain-

ous parts of the coast at the eastern end of the island, while the great bulk of the land doubtless will be devoted to the growth of the sugar cane and tobacco plant, for it is certain that these two plants thrive to an extent in Cuba unknown elsewhere. It seems that the climate and the soil combine conditions very favorable to their growth and to their harvesting. These industries present radically different aspects. In the case of tobacco we have numbers of small cultivators, in the field, and great institutions where the rolling and packing and marking of the finished product is chiefly hand-work ; so that the chief elements of success are the employment of great numbers of men and women who have the necessary skill, at the lowest price, and the careful organization of them to insure their efficiency. The tobacco industry undoubtedly offers a good field for the investment of capital, and, further, is a ready way in which a man with small means and a little good land may make his land pay him well ; but it affords little scope for the engineer or contractor. Its great strength lies in the unrivalled quality of the leaf.

The sugar industry, on the other hand, affords a wide field for many kinds of enterprise.

Cuba, in times of peace, produces about one million tons of cane sugar, more than twice as much as Java, the next largest cane sugar country of the world, and more than five times as much as any other cane sugar country. Among the beet sugar countries it is surpassed only by Germany, with one and one half million tons, and is equalled only by one other, Austria. It must be regarded as a singular state of affairs that, while in all the other West Indian islands, and, in fact, in nearly all cane sugar countries, the industry is in a desperate state, warranting special commissioners to inquire into its illness and its needs, the Cuban industry has gone ahead and prospered under a government which pillaged it steadily, in spite of outrageous railroad freights, bad shipping facilities, the heart-breaking question of European bounties, and discrimination to its detriment by American buyers. The reasons why it has prospered are quite clear. First, the climate and soil are admirably adapted to the needs of the cane ; secondly, the Spaniards and Cubans have had the courage to centralize their sugar houses and go at the business individually, on a scale unequalled in any other country on the globe. Old, small places were replaced by powerful factories equipped with the best of modern machinery, narrow-gauge roads were built in all directions, and, in short, great sums were spent, and spent well. The main essentials of competing with the beet sugar countries were understood and complied with, while in the other islands they are still hesitating.

It is not within the scope of an article like the present to go into the

details of sugar manufacture, but I may briefly point out that, first, great tracts of land are available for sugar cane which are yet a wilderness, and, secondly, that in the cultivation of the cane, both in the preparing of the land and in the planting and harvesting, there is a crying need of machinery. The planting of the cane is nearly all done by hand. There are a few cane-planting machines, but little is known about them. The weeding is done by hand in the majority of instances, and finally the harvesting is done with a knife, and a laborious business it is. It takes five hundred men per day to cut the cane alone, on a large estate, to say nothing of loading and teaming to the railroad tracks; and the man who can successfully solve the problem of a cane harvester has a large field to work in.

The machinery used in the manufacture of sugar on a large estate is very extensive. A large "Central" will grind 1,000 tons of cane in 24 hours, or, say, 100,000 tons in a season of 100 days. A boiler capacity of 1,200 to 1,500 h. p. is necessary to do this, nearly all of which power is used for driving the various pumps and engines, the evaporation being performed by the exhaust steam. Such an establishment is worth in Cuba about half a million of dollars, and its annual output is worth about the same amount. Three or four locomotives and about one hundred cars are necessary to haul the cane, and about 1,000 men altogether are employed in the field and in the works. Besides, one to two thousand head of cattle for hauling and slaughtering are needed. There are very many such establishments in Cuba, and there is room for more.

The supplying of the sugar houses with new machinery has been an enormous business in the last decade. It has been in the hands of the Scotch, French, and American machine houses mostly, as the German and other continental houses have fought shy of the long credits demanded, the insufficient security, and the general lack of good faith in Cuban business affairs. There can be no doubt that much new business in this direction must spring up with the settlement of the present dispute, and it will doubtless gain in security with time.

In looking at the future development of Cuba we have to consider the question of labour. This is of three kinds,—white, black, and yellow. The white labour consists of native Cubans, natives of the Canary islands, and Spaniards, of which the latter are far the best for general work.

After some experience in many countries, I have yet to see a harder-working or more peaceable lot of men than the native Spaniards.

The Canary islanders and the Cubans are less sturdy and less trustworthy, but, especially in the case of Cubans, more intelligent. The blacks are a strong, vigorous race, having much more of the savage in

them than those in the southern States or Jamaica. They resist the enervating influences of the climate far better than the whites, and are better field hands, but dull to a degree. The Chinese are all old men, brought there in slavery times and still practically slaves, as they work entirely by contract. You employ a "Capataz," as he is called, and he furnishes you so many men to do so much work every morning at so much per man. These men are wonderfully steady, and do work out of all proportion to their strength, but their strength is very little.

The pay of the common labourer varies very much with the times. In the active season he gets about 15 Spanish dollars per month and his food and board, both of the roughest kind. It costs about 7 dollars per month to feed a man where the men are best fed, and considerably less at other places. At the present time the pay has run down in the dead season to $10; indeed, in many places men work for their food alone.

The Spanish silver dollar is worth about 65 cents, so that you get very good labour for about $15 a month, American currency. The pay of mechanics ranges from 40 to 100 dollars per month, according to ability.

Among industries which have received very little attention as yet, the fruit industry may be mentioned. Extensive banana plantations exist on the north coast, and fine apples are produced, but one great destructive influence, that of the cyclone, is to be counted with in growing fruit. Still, the business is said to be profitable, and certainly admits of great extension, and perhaps of an improvement in the kind of banana used for export. The more delicate kinds should find a great sale in the north, should some one succeed in getting them there in good condition.

Other tropical fruits, oranges, lemons, mangoes, alligator pears, guavas, etc., grow wild and in extraordinary abundance, but almost nothing has been done to produce them commercially. The soil of Cuba is one of the most fertile soils in the world.

The climate of Cuba has been much maligned, but not in the right way. Yellow fever and very bad kinds of malarial fevers certainly exist, as well as small pox, but almost solely in the larger towns, where, as has already been stated, the sanitary conditions are abominable. In the open country few people are attacked, and these few only in the wet season. The seasons are sharply divided into the dry one, from about November 1 to about May 15, and the wet one, the remainder of the year. The total rainfall is about 50 inches, and occurs mostly in the fall months. At no time is the heat very great, nor is frost known, except at considerable altitudes, the extremes being about 45° and 95°. The nights are always cool, and in the winter time a

more delightful climate does not exist. But of its enervating influence there can be no doubt. It is to be seen in every man who spends a few years continuously on the island, and is to be seen in white children born there.

Let the northern man who embarks in any enterprise there provide a long holiday every year, or he will rue it surely.

We have now to consider, as an offset to the pleasant side of the picture, four great destructive influences that have to be counted with in Cuba. They are drought in the winter time, cyclones, fire, and revolutions. The first-named is not very frequent; the second occurs in the fall and about every two years; the third is the great enemy of the cane, which, being full of dry trash, is most inflammable; and the fourth may be expected about every ten years. All of these, including the latter, must be carefully taken into account. Peace is not for Cuba for years to come.

Fire in the cane is a very serious matter. The success of the insurgents is greatly due to the power of destruction which lies always at their hand in this direction. A cigarette stump on a windy day will burn a thousand tons in an hour, and force the planters to cut and haul the cane inside of a few days, or lose it by fermentation of the juice.

Even in times of peace armed and mounted men are needed to patrol the fields and watch the workmen, while in times of revolution, like the present, it costs an estate thirty to fifty thousand dollars a year to defend its fields. This is the history of the past and present time, and the writer cannot think that there will be a speedy change.

The whites control the island, and outnumber the colored races. There may be trouble yet between the races, but the whites will win in any struggle, and preserve the island from the fate which has overtaken Jamaica, San Domingo, and others. The domination of the blacks means industrial and political death. Infinitely better would it be for the island to continue under its present misrule than to pass under the control of the negro, as all who have lived among a mixed population can testify. Any investor or settler in Cuba must, from the beginning, fight heart and soul against anything that will give power into the negroes' hands, for they will use it mercilessly against the whites.

MECHANICAL OPERATIONS IN THE MANUFACTURE OF A GREAT NAVAL GUN.

By Edwin J. Prindle.

A STRIKING feature of modern engineering development is the rapid overlapping of the provinces of military and civil work, using the latter term in its broadest sense. This is especially true of naval construction; and to England, which can be attacked only by sea, and to the United States, with its enormous coast line, the navy is a vital portion of the military establishment.

The modern ship of war is a huge aggregation of machinery, demanding the highest engineering skill for its creation and management. And this is true not only of the hull and the main and auxiliary machinery, but of the engines of offence and defence of which the great gun is the heaviest unit. It is a product of machine-building on the largest scale, proportionate to its importance in the fighting force of the vessel which carries it.

The smaller guns fire more rapidly than the big guns; but their shot can be effective only on the weaker parts of an armored vessel. The torpedo is deadly in its effects, when it succeeds in striking; but, if it is seen in time, the rain of shot from the rapid-fire guns will explode it at a safe distance, and, even if the torpedo escape this danger, it may be stopped by the torpedo nets which surround the vessel attacked. But the big gun of the navy in its largest size—thirteen-inch bore—is capable, under favorable conditions, of penetrating the heaviest armor afloat. It is the only weapon against whose attack there is no protection.

It is of interest, then, to inquire how the present form of big gun originated, what are its parts and operations as a machine, and by what processes it is constructed.

The big guns of the American civil war were almost entirely smooth-bore cast-iron cannon, which fired a spherical shot. The pressure which such a gun could resist was small, and the range was consequently short. The cast-iron guns, on account of their low power, could penetrate but a few inches of wrought iron; and, as the thickness of the armor was increased and greater toughness and hardness given to it, the construction of stronger guns became a necessity. A mere increase in thickness, beyond a certain limit, of the walls of a single-piece gun does not increase its strength.

The spherical shot could crush in the side of the old wooden or lightly-armored vessels; but, with the advent of heavy armor, it became necessary to devise a means of penetrating the side of the vessel.

By elongating and pointing the projectile its action was confined to a small area with greater effect, and the penetration was thus secured. The change in the projectile caused a change in the gun. If fired from a smooth-bore gun, the elongated projectile would go end-over-end, exposing a great deal of surface to the air and striking anywhere but on its point. To keep the projectile end-on, spiral grooves were cut in the bore of the gun, and the projectile was furnished with projections which engaged the grooves, resulting in a rapid rotary motion which compelled it to travel point forward. But, the base of the projectile being of less area than that exposed to the pressure of the gases by a ball of the same weight, greater pressure in the gun and,

SECTION OF A 13-INCH GUN.

consequently, greater strength were required. It is desirable to further increase the pressure in the gun, in order that the trajectory, or line of flight, may be as flat as possible and the greatest accuracy and range be thereby secured.

To meet these severe conditions the big guns are now made on what is known as the "built up" principle, and of a length nearly three times that of the smooth-bore type. In the longer gun the gases have more time to act on the projectile before it leaves the gun, and, consequently, a slow-burning powder can be used, which, while it evolves the gas rapidly enough to keep up the pressure behind the projectile as it moves through the gun, avoids the needlessly great initial pressure of the quick-burning powder. The working pressure in a thirteen-inch gun of to-day is fifteen tons per square inch, and pressures as great as thirty tons per square inch have been recorded.

At first, owing to unskilful workmanship and use of material, the built-up guns were not successful, and a hundred shots was the average service of a big gun.

In the built-up gun the bore is formed in a tube of uniform diameter, and then several layers of hoops or bands are shrunk on, by making each part smaller than the one it embraces, expanding it by heat, and allowing it to cool in place on the gun. The parts of the gun, beginning with the tube, are in a state of compression, which decreases gradually outward until the outer layers are under tension. The pressure of the powder first overcomes the compression of the tube, and then puts it under tensile stress, at the same time being communicated to the outer layers, each of which bears its share. The shrinkage, or original difference in diameter between a hoop and the

BORING A JACKET.
The boring head on the boring bar is about to enter the jacket.

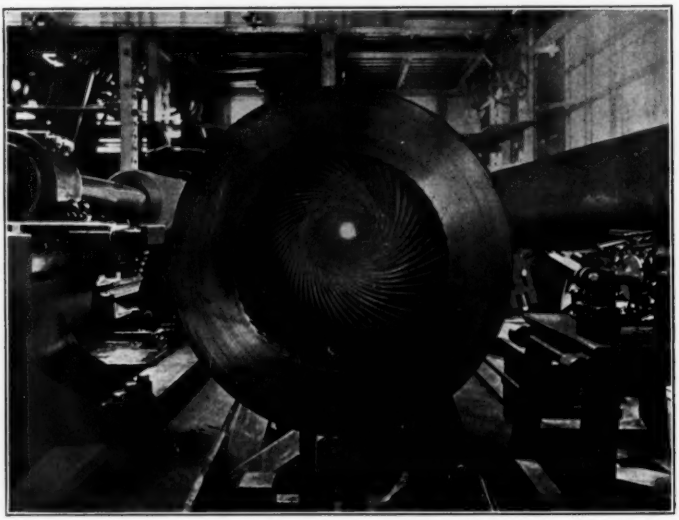
part on which it fits, is so calculated that the tube is not compressed beyond its elastic limit, nor is the outer hoop under such tension that it will pass the limit of its elasticity.

The foundation of the gun is a tube of uniform exterior diameter, which contains the powder chamber and the entire bore. A large sleeve called the "jacket," of about three-fifths the length of the tube, is shrunk on the rear portion of the tube, and extends enough farther to the rear to contain the breech mechanism. Three layers of "chase-hoops" are shrunk on the "chase," or portion of the "tube" extending from the jacket forward, and a locking band is screwed on the tube to hold the foremost chase-hoop in place. The jacket is embraced by a layer of "jacket-hoops." The chase-hoops interlock with the tube and with each other to prevent the forward portion of the tube from being blown apart from the rear portion; the jacket and forward jacket-hoop are similarly interlocked; and a locking band is screwed over the joint between the series of chase-hoops and the forward jacket-hoop to lock them together, thus effectually preventing the gun from breaking through transversely.

The thirteen-inch gun of the United States navy is forty feet in length and four feet in diameter, and weighs, unmounted, 145,000

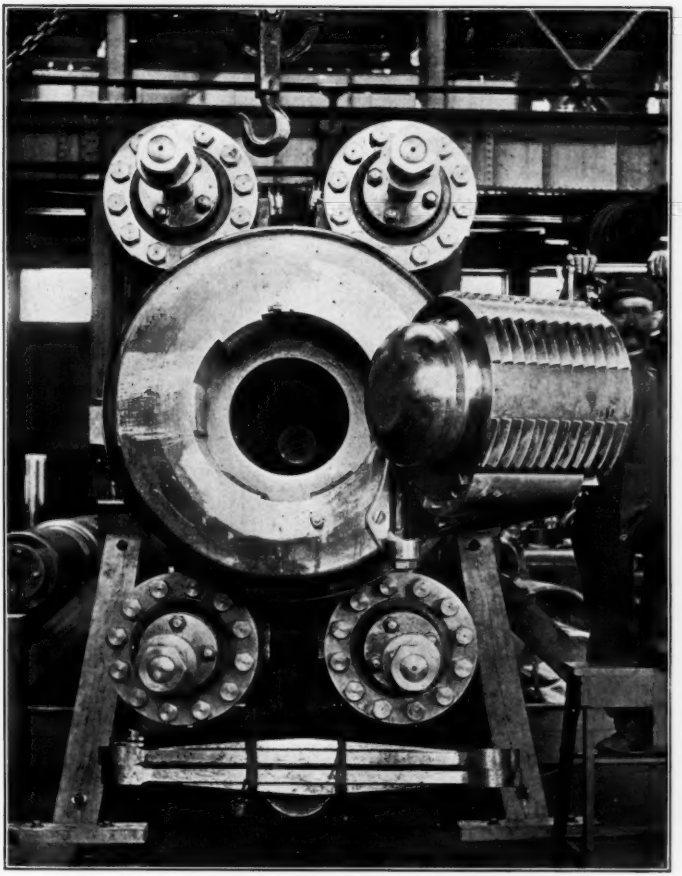
pounds,—a weight equal to that of a very powerful locomotive. The tube of the gun is two feet in diameter and thirty-eight and one-half feet long. The jacket is more than three feet in diameter and seventeen feet long. The bore is uniformly thirteen inches in diameter from the muzzle backward for four-fifths of its length, where it gradually enlarges to form the powder chamber.

The bore is provided with fifty-two rifling grooves, which decrease in width as they approach the muzzle. The grooves are straight forward at the rear of the bore, but gradually turn until, at



LOOKING INTO THE MUZZLE OF A 13-INCH GUN.

the muzzle, they give the projectile one turn in twenty-five calibres. In the overhanging portion of the jacket is the "screw box," into which is locked the "breech plug," which closes the rear end of the gun. The breech plug is cylindrical in form, and its surface is provided with a heavy screw-thread. The thread is cut away in six equal spaces. The cylindrical surface of the screw-box is correspondingly formed, so that, in screwing the breech-plug home, it is necessary only to place the thread sections on the block opposite the blank spaces of the screw-box, and slide the breech-plug clear in, when a turn of one-twelfth will engage the two systems of threads and lock the breech plug in place.

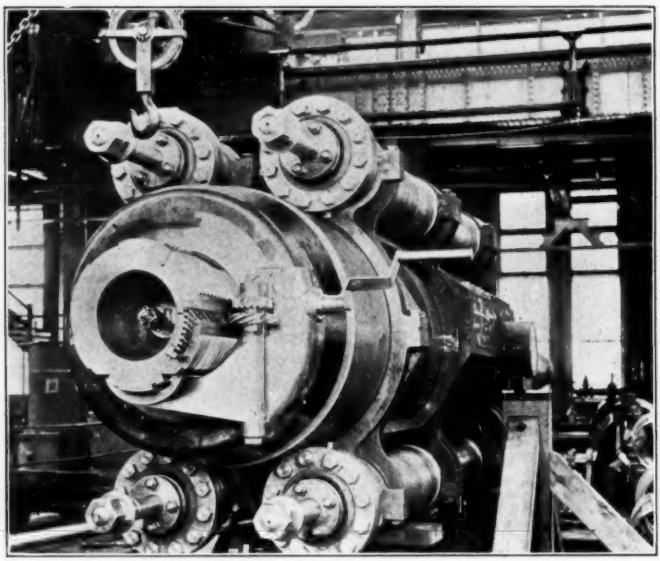


THE BREECH-PLUG SWUNG ONE SIDE.
The projectile may be seen in place in the bore.

The breech-plug, when out of the screw-box, is supported on the "plug-tray," which swings on a vertical shaft secured in bearings fixed on the rear end of the gun. The plug-tray has a guide-way to receive one of the screw-sections of the breech-plug as the plug slides out of the screw-box; and, when the breech-plug is entirely out of the gun, it is locked on the tray, and the latter swings on its shaft to carry the breech-plug to one side. All these motions are

performed simply by turning the shaft that supports the plug tray by means of a worm-wheel gearing and hand crank. On the shaft below the worm-wheel is a wheel which first acts (as a gear wheel) on a rack fastened on the breech-plug to slide the breech-plug into the screw-box, and then acts (as a worm-wheel) on a worm-rack at the end of the gear-rack to turn and lock the breech-plug in place.

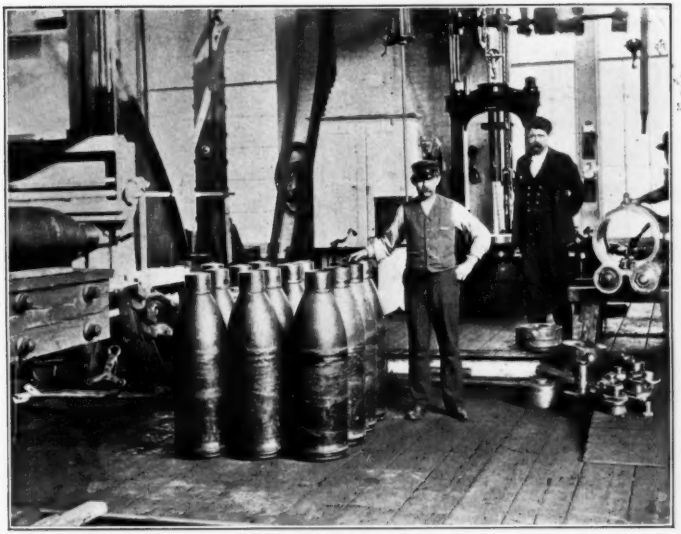
Perfection of workmanship cannot be depended upon to prevent the gases from escaping between the adjacent surfaces of the breech-



BREECH-PLUG READY TO ENTER THE SCREW-BOX.

plug and screw-box under the enormous pressure of the explosion, and this necessitates a "gas-check." The "mushroom" (a piece of steel having the shape of the plant from which it is named) has its stalk secured in a central hole in the breech-plug. Its head nearly fills the slightly-flaring rear end of the powder-chamber, and between the head and the end of the breech-plug is a canvas ring filled with greasy asbestos. The explosion forces back the mushroom head, and squeezes the ring so that the passage is securely closed.

In the rear end of the mushroom stalk is secured either the spring lock or the electric-firing mechanism according to the method of firing the charge,—a lanyard (or cord), or electricity. The spring

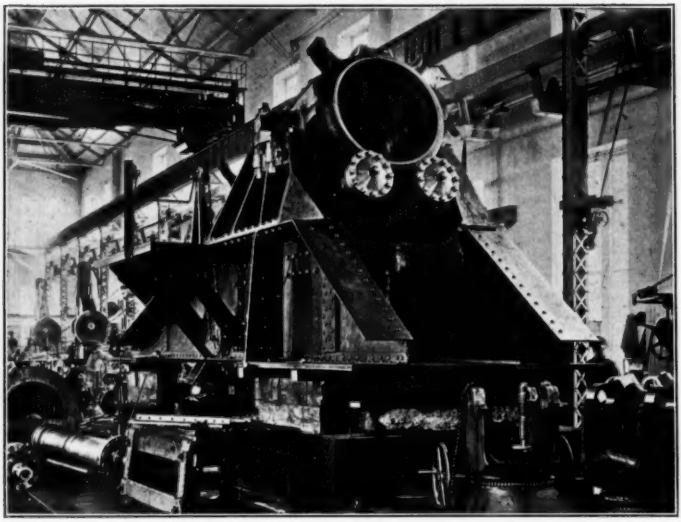


A GROUP OF 13-INCH PROJECTILES.

lock, in principle, is like the lock of a shot gun, having a firing pin (corresponding to the hammer of the gun) that is driven against a percussion cap in the primer by a spring when released by a pull of the lanyard on the trigger. The explosion of the percussion cap sets off a small charge of quick-burning powder in the primer, and the flame from the powder, escaping through a passage in the mushroom, reaches the large charge of powder in the powder chamber, causing it to explode.

The projectile is three and one-half feet high and of course, thirteen inches in diameter. It weighs 1,100 pounds. In a groove passing around the projectile near its base is secured a copper ring, slightly larger than the projectile, which is forced into the rifling grooves by the compression slope in the gun. This is the sole means of engaging the projectile with the grooves.

The hardened point of the projectile is covered by a flat soft-metal cap, which holds the metal of the point together at the instant of impact, enabling it to enter the hardened armor. The projectile carrries forty pounds of quick-burning powder in a chamber within it, and this powder is exploded when the projectile strikes, thus blowing it to pieces. The powder chamber is closed by a large screw-plug, which carries the primer in a hole at its centre. The primer has a



TURRET MOUNT OF 13-INCH GUN FROM FRONT.
The two lower recoil cylinders are in place on the sleeves, the upper ones being removed.

small plug, or hammer, which is held in a pocket by a brittle wire on which it is hung. As the projectile starts, the hammer breaks the wire and falls free to the bottom of the pocket. When the projectile strikes an object, the hammer is thrown forward against a percussion cap, and explodes the charge in the projectile.

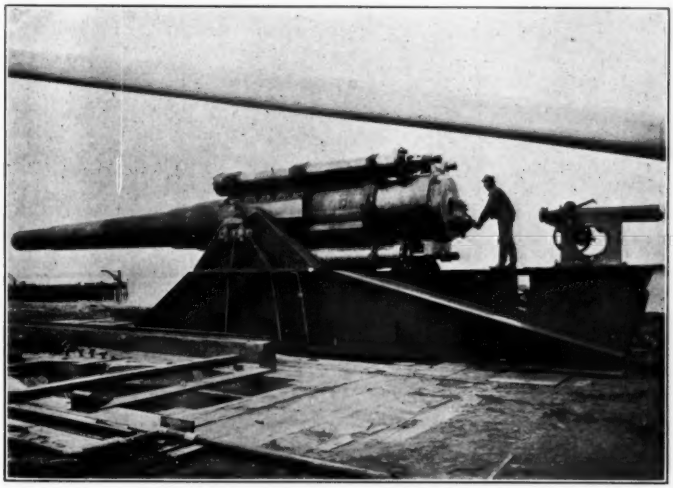
The gun is mounted in a "sleeve" pivoted in the "deck lugs" of the turret. A key, or bar, is secured in the gun, and fits a groove, or key-way, in the sleeve, to prevent the gun from turning in the sleeve, while allowing it to slide longitudinally. The gun recoils with a force of two hundred and twenty-five tons; yet this enormous strain is taken up, and the gun brought to rest, in the space of forty inches.

To take up the recoil four "recoil cylinders" are mounted in rings formed on the sleeve, and the rods of the pistons in the recoil cylinders are attached to a ring on the breech of the gun, so that the pistons go with the gun, and the recoil cylinders are fixed on the sleeve. Surrounding the piston rods within the recoil cylinders are twelve nests of heavy springs, which take up a large part of the recoil. The movement of the pistons is further retarded by a mixture of glycerine and water, which is allowed to escape past the pistons through grooves in the walls of the cylinders. At the limit of move-

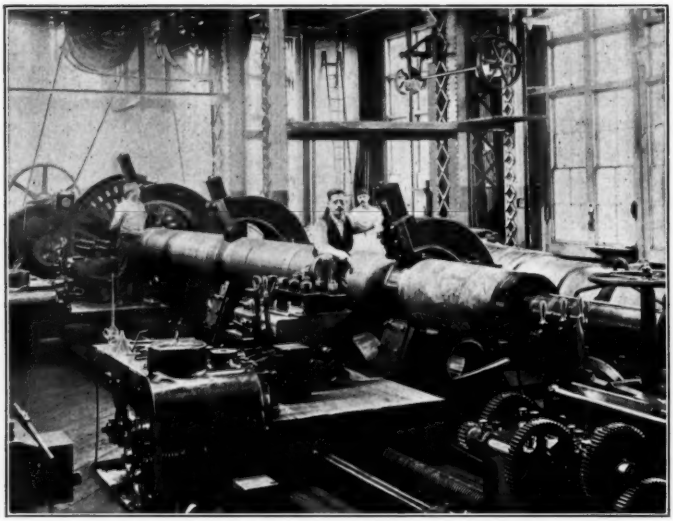
ment of the pistons the grooves end, and thus the pistons are stopped entirely. As the pistons recede on the recoil, they draw in water and glycerine behind them, and a valve prevents the outflow of this mixture, thus holding the springs from returning the gun to battery suddenly. By slowly opening the valve the latter operation is accomplished quietly.

The sleeve in which the gun slides is pivoted at the front on two trunnions, and is supported at the rear by a pair of links pivoted to the sleeve at their upper ends and, at their lower ends, to the sides of a nut travelling on an inclined screw. The screw is mounted in bearings, and is rotated from a hand-crank connected to it by sprocket-gearing to raise and lower the nut and, by this means, the gun. The lower end of the screw rests on a strong spring, to allow the screw to yield at the moment of recoil. Thus the elevation and depression of this ponderous gun are accomplished by hand, although a motor may be used if desired. At the rear of the gun mount is a rammer. Although this rammer is only about five feet long when contracted, its head may be extended fourteen feet by an ingenious arrangement of telescopic tubes. It may be operated by hand also.

The sighting is done through a telescope in the sighting hood, which is so connected by levers to the sleeve of the gun mount that it is always parallel with the gun. The gun captain in the sighting hood, by control of the motion of the turret and of the motor or men



13-INCH GUN WITH TURRET MOUNT, AT INDIAN HEAD PROVING GROUNDS.



BORING A TUBE FOR A 13-INCH GUN.

operating the elevating mechanism, sights the gun so that it points at the desired spot when the vessel is at the top of its roll; and, at this moment of rest, he pulls the lanyard or presses the electric button which fires the gun.

An expert gunner cannot be made entirely by training. Under the regulations of the United States navy each member of a gun crew is made, at practice, to try his hand at firing; and, from the records of the results, the gun captains are chosen. In one instance an apprentice boy of eighteen made so uniformly fine shots that he was promoted to the position of second gun captain. Some of the commissioned officers never become good marksmen.

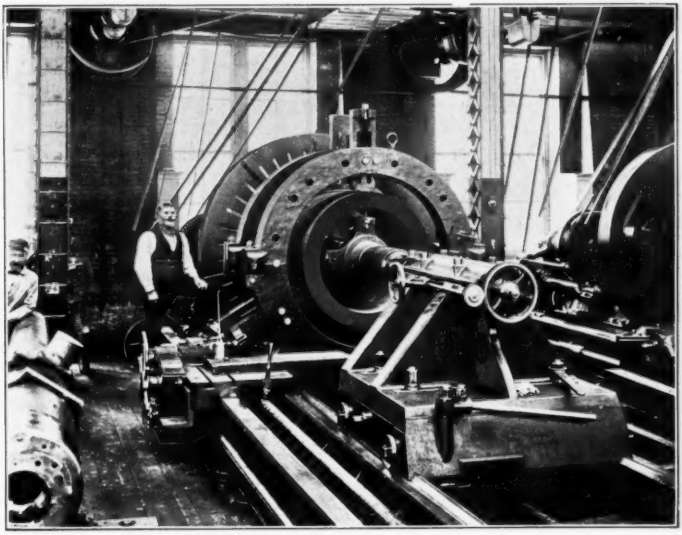
The principal parts of the gun are made from cast steel, tempered in oil, and carefully and repeatedly tested for strength and elasticity. The hoops and jackets are cast solid, and then a hole is bored through them to admit a mandrel, on which they are forged to elongate and enlarge them. The forging is tempered in oil and roughly finished, after which it goes to the naval gun factory at Washington, D. C.

In turning the partly built-up gun to prepare it for receiving the next layer of hoops, the gun is clamped to the face-plate of the head-stock spindle, and its muzzle is fitted with a plug in which is a conical hole that fits over the dead-centre on the tail-stock at the other end

of the guides. Rests, or goose-neck supports, are placed at intermediate points on the guides to take part of the weight of the gun. As the gun revolves, the tool with its carriage is moved slowly along the guides by a large screw. In turning the outer surface of one of the jacket hoops, the tool, in going once across from end to end, travels twelve miles, and occupies fifty-six hours in the operation.

In turning the inside of a hoop, the hoop is clamped in ring-like supports fastened on the tool-carriage, and the tool is secured in an arm on a mandrel, or bar, clamped to the head-spindle and supported on the dead-centre. As the tool cannot move along the guides, the hoop is moved slowly past the tool by causing the tool-carriage to move along the guides.

The outer surfaces of the tube, jacket, and hoops are turned in the same manner, but the bore and inner surface of the jacket are finished by the use of "boring-heads," or cylindrical heads having four cutters fastened in their forward edge. The head has four segments of wood fitted in grooves in its surface, and, when it is forced into the revolving tube or jacket by the boring bar on which it is carried, the wood is squeezed, holding the head in the bore so rigidly that it



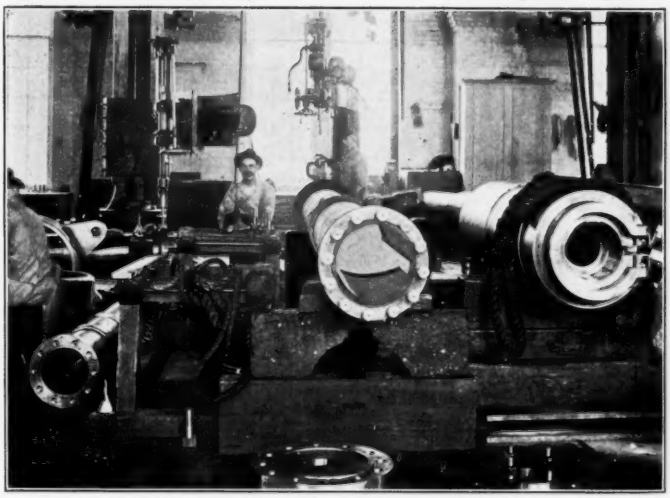
TURNING THE INSIDE OF A HOOP.
The tool is carried by the revolving mandrel, and the hoop travels along on the tool carriage.

SHRINKING A JACKET.
The jacket, taken from the open furnace in the foreground, is descending over the tube.

is compelled to travel in a remarkably straight line while the cutters act, thus ensuring a perfect bore. So accurate is the work that the bore, although thirty-two and-a-half feet long, is not usually more than .002 of an inch out of a straight line.

In assembling the gun the tube is first bored and its outer surface finished; then the jacket is finished inside, and shrunk on the tube. The shrinking of a jacket is an event at the shops, and usually attracts

a good deal of attention. The jacket is heated to a temperature of 600° F. in a cylindrical furnace built in a large pit forty feet deep. Air, blown through a tubular furnace maintained at a white heat by burning sprayed crude oil, is forced through and around the jacket for twenty-nine hours. The burning blasts of oil make a roaring that interferes with conversation, and the entire operation is directed by signals and without one spoken word. The tube has previously been

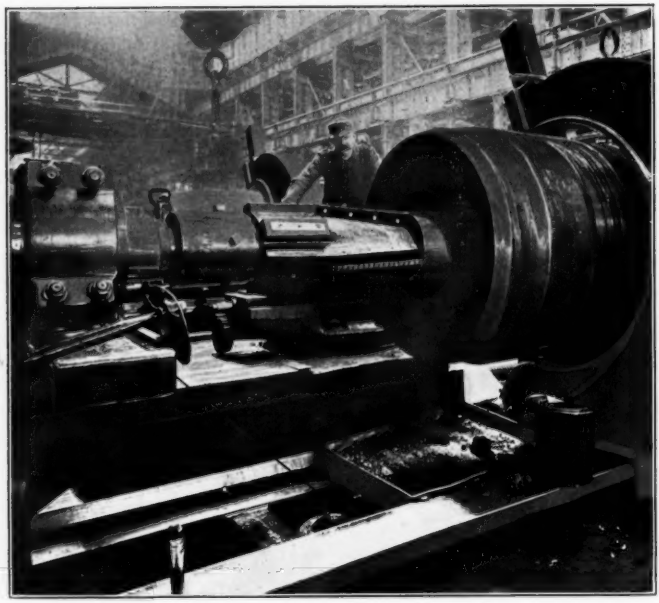


A RECOIL CYLINDER, SHOWING ITS GROOVES.

placed, muzzle-down, in the pit, and pipes are arranged to run water into the interior of the tube to keep it cool.

When all is ready, the foreman claps his hand and motions upward. A crane, travelling on overhead tracks, raises and carries away the iron cover of the jacket-heating furnace. A larger crane now comes, and, by chains hooked to trunnions on a ring clamped to the end of the jacket, the huge jacket, seventeen feet long and weighing 40,000 pounds, is raised from its casing as easily as you would draw a newspaper from its wrapper. To see if all parts of the jacket are evenly heated to the proper degree, the foreman rubs the surface, as it rises from the furnace, with sticks composed of alloys that melt at certain known temperatures.

The jacket is now swung to one side, and a star-shaped gauge is thrust through its bore to see if the heat has enlarged it sufficiently to go over the tube. The bore is found to be correct, and is cleaned out with canvas-covered swabs. The crane carries the jacket to the



CUTTING THE COMPRESSION SLOPE.

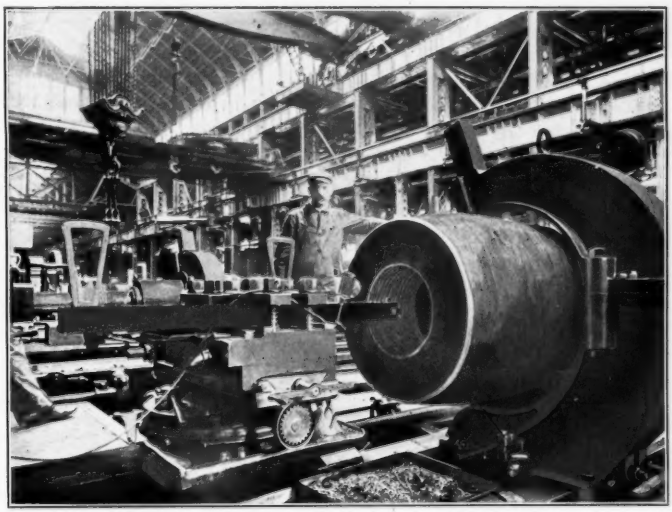
tube, over which the foreman, by motion to the crane man, carefully centres it. Four men protected with asbestos gloves now steady the jacket as it slowly descends on the tube. The crane which handles the jacket can easily carry off the finished gun, and yet it possesses such delicacy that the jacket is centred within one thirty-second of an inch and is lowered at the rate of but a foot in a minute.

After the jacket has cooled and shrunk on the tube, its outer surface is finished in the lathe, and the hoops are shrunk on. The outer surface of each part is finished after it is in place on the gun.

The compression slope, where the copper ring on the projectile enters the rifling grooves, is formed by feeding-in a reamer on a boring bar while the gun revolves. The reamer is a conical head, having four longitudinal cutters secured to ribs on the head. A larger brass ring on the head bears in the screw-box (which is not yet provided with its screw), and a smaller brass ring bears in the, as yet, smooth bore of the gun. The cutters, acting on the shoulder between the bore of the gun and the powder chamber, cut out the revolving gun, until a gradual slope connects these parts.

The next operation is the cutting of the screw-thread in the screw-box. The gun is, as before, revolved by the lathe, and a tool (whose point is the shape of the space between two threads of the screw), is clamped in the carriage of the lathe, and the carriage is moved forward by its screw about one and one-half inches for every turn of the gun on its axis. This motion, causing the point of the tool to trace a spiral in the screw-box, forms the thread. The six blank spaces in the screw-box are cut out by a tool that reciprocates longitudinally, the gun being slowly turned step-by-step between the movements of the tool.

In the rifling lathe, the gun is blocked up in line with the rifling bar, and a rifling head is attached to the latter. The rifling head is cylindrical and fits the bore accurately. It carries four cutters of the shape of the rifling grooves. The rifling bar has a groove in its surface which has just the twist desired for the rifling grooves, and a stationary pin, which engages the groove in the bar, causes it and the head to turn in the proper manner to form the rifling. When four grooves are thus finished, the rifling head is turned one fifty-second of a turn, and four new grooves are cut. The keyway in the top of the gun is cut when the rifling is being done, by a small milling machine mounted bodily on top of the gun. In this machine a horizontally-revolving milling cutter is fed by a screw to cut the key-way.



CUTTING THE SCREW IN THE SCREW-BOX.

The breech mechanism, which is made in a separate shop, is attached while the gun, carefully greased, lies out of doors. To avoid taking the gun into another shop, a little knock-down house is hooked together around the breech while the mechanic, by electrically-driven tools, attaches the breech mechanism.

The finished gun is placed in the sleeve of its mount, and all the parts of the mount are put in place, or else an equivalent weight is attached. The whole mass is now raised, and placed on steel wedges supporting the large lugs on the sides of the sleeve from which the trunnions are to be formed. These lugs are made sufficiently large to allow the trunnions to be so located as to perfectly balance the gun. If the gun is accurately balanced, the power necessary to elevate and depress it is comparatively slight. The wedges are tried back and forth until, when finally placed, the gun muzzle can be raised and lowered by the hand of a woman. The officer in charge can calculate the position of the trunnions within one-tenth of an inch. Marks are now made to locate the centres of the trunnions.

The United States navy department has twenty-eight of these thirteen-inch guns. The battle-ships Indiana, Massachusetts, and Oregon have each been furnished with them, and the Kearsarge, Kentucky, Alabama, and Wisconsin will each have four.

It is difficult to appreciate the power, and at the same time the delicacy, of these great fighting machines. At the muzzle the immense projectile has been forced through twenty-seven inches of Harveyized steel. At two thousand yards the penetration is twenty-two-and-one-half inches. The extreme range is thirteen miles. The projectile leaves the gun with a velocity of 2,100 feet per second, or 1,400 miles per hour. A shot can be fired every one and one-half minutes for a period of several hours. The force imparted to the projectile, if properly applied, would lift a battle-ship bodily three feet, and yet this great machine, weighing 145,000 pounds, is as accurate as a high grade watch.

THE DEVELOPMENT OF THE RAILWAYS OF CANADA.

By Walter E. Weyl.

MUCH of the acrimonious discussion over the question of State versus private ownership of railroads might be averted, did the advocates of either system recognize the limitations of their own arguments. It is characteristic of such dialecticians that they apply the results of one nation's experience to the problems confronting another, without considering the modified circumstances by which such experience is conditioned.

It is especially necessary to take this national equation into account in comparing the railways of Canada with those of the United States. The experience of these nations presents a series of parallels and contrasts directly traceable to the similar, or to the diverse, conditions existing in the two countries. Both in Canada and in the United States railways have grown more rapidly than population; in both countries they have often preceded roads, and even settlement itself; in both the lines have been cheaply and rapidly constructed, and have been extended into the most sparsely settled districts. In Canada as well as in the United States the main arteries of railroad communication run east and west; in both countries the policy of private construction, ownership, and management has prevailed; and generosity towards the railways, as exemplified by large grants of land or money, has been common to the governments of both. The contrasts in the policy adopted on either side of the boundary line are equally striking, if less important; but the underlying similarity in the railroad history of the two countries can be shown to have its cause in the like economic conditions and tendencies prevailing.

The English, on the whole, have favored a policy of private ownership of home, and of governmental ownership of colonial, railways, but to this rule the case of Canada furnishes an exception. While the railways of India, of Australia, of the Cape, of Natal, etc., have been largely constructed or managed by government, the development of the railways of Canada were at first left to individual initiative. This *laissez-faire* policy of the government may be attributed in part to the economic doctrine then supreme in England, but it was no less due to the discouraging outlook for railroad enterprises in Canada. At the beginning of the railway era the total population of British North America scarcely exceeded half a million, and these were mainly clustered in what are now the provinces of Quebec and Ontario and within easy reach of the great lakes and the

St. Lawrence. Separated from the unknown territories of the west and from the maritime provinces of the east, even these tracts were too thinly peopled to invite large outlays for railroads, particularly in view of the exceptional advantages presented by cheap inland navigation.

These adverse conditions were as potent in checking private enprise, however, as in discouraging governmental activity, and the result was that, for a considerable period, the development of Canadian railways was exceedingly slow. As late as 1845 an insignificant sixteen-mile road from La Prairie to Quebec was the only railway within British America. During the fifties, however, the construction of the Grand Trunk, the Great Western, the Northern, and other lines was begun, and the mileage quickly grew from 71, in 1850, to 2,087 in 1860. The increasing population, the expansion of the settled area, the opening up of new lands to agriculture, and the steady increase in wealth and industry were causes, as well as effects, of improved means of land transportation, and, after the consolidation in 1867, economic, political, and military considerations united to increase the extent of the railroad net. The Grand Trunk continued to grow in length, the Intercolonial and Prince Edward Island railways were constructed, the Canadian Pacific was pushed forward to a speedy completion, and branch lines were everywhere thrust out to the margin of settlement. The length of the railways increased from 2,150 miles, in 1866, to 5,157, in 1876; to 10,697, in 1886; and to 16,270, in 1896, the length of road in operation during the year 1897 amounting to 16,550 miles. The present extent of Canadian railways is thus only one-eleventh of that of American lines, but, with an approximately equal area, Canada's population bears a still smaller proportion to that of the United States; and, despite the fact that the dominion contains less than five million inhabitants, there are but seven countries in the world that can boast of a railway mileage greater than that of Canada.

This rapid development is to be attributed, in no small degree, to the financial aid of the State. Grants of land and money have been made by the dominion, by the several provincial governments, and by municipalities, and of a total paid-up capital of $920,000,000 no less than $197,000,000, or 21.4 per cent., was thus contributed, the average subsidy amounting to about $12,000 a mile.

Of the total amount thus granted, the dominion contributed more than three-fourths, or about 76 per cent., the municipalities 8 per cent., and the provincial governments 16 per cent. Among these latter the government of Quebec has been unusually lavish, furnishing almost half of the total provincial contributions, and, with a railway mileage

not half so great as that of Ontario, more than doubling the donation of that province.

This policy of fostering the growth of railways by government subsidies has been subjected in Canada to considerable adverse criticism. It has been argued that the taxpayers have made immense sacrifices; that the lavish donations of the State have resulted either in the destruction of national wealth, or in its conversion to the uses of private persons; that this generosity has had a demoralizing effect upon the railways themselves; and that it has tempted them to convert Ottawa into one great lobby. These views, however, are far too pessimistic. A government subsidy should always be in the nature of a sacrifice. The policy has its *raison d'être* in the desire to combine the advantages of private and of State construction of railways, to encourage the growth of useful, but unprofitable, lines, without sacrificing the impetus derived from individual initiative. In populous and highly-developed countries, such as France, this assistance of the State has been principally required for the construction of local lines (*réseau nouveau*), but in Canada the government subsidies have aided the extension of the net by the construction of long through lines.

The favorite child of the dominion has been the Canadian Pacific. That company has received a grant of $15,000,000 in cash, 25,000,000 acres of land, and about 640 miles of completed track, the last item, including preliminary surveys, costing the government some $33,000,000. The advantages accruing to the dominion from these sacrifices have been very great. Canada, east of Lake Superior, has always had the advantage of water connection with the Atlantic ocean from the end of March until the end of November, but west of the lakes communication was almost non-existent. Between Port Arthur and Winnipeg there was only "the old canoe route," which, moreover, could not be used to transport immigrants, and there was no connection at all with British Columbia. Half a century ago the necessity of an inter-oceanic line had already been felt, and in an open letter, in 1847, Major Carmichael Smith wrote as follows: "This great national highway from the Atlantic to the Pacific is the great link which is required to unite in one powerful chain the whole English race." But, while the United States rapidly completed several of these "great links," the Canadians, with their smaller population, lagged behind. After the consolidation, however, an extension of the railroads towards the west became a necessity. At this time there were no railroads in Manitoba, in British Columbia, or in the northwest, and even ten years later the conditions were hardly changed. Without the iron road the consolidated was a union in name only,

and therefore in 1871 the government commenced the extensive survey of the territory through which the Canadian Pacific was destined to pass. In 1877 the dominion began the construction, but by 1881 it was decided to hand the enterprise over to a private company, on the condition that the road should be finished by 1891. This condition was more than fulfilled. By 1886 the railroad was completed, with a mileage of 4,533, and since then it has rapidly grown by new construction and by buying, leasing, or operating other roads, until at present it represents the consolidation of twenty-one Canadian lines, and owns or operates about 7,251 miles, about a seventh of which is situated within the United States.

The Canadian Pacific is neither the first or the only railway in Canada which has grown by the absorption of other lines. Amalgamation has taken place much the same as in England, France, and the United States. Of the 144 railway companies in Canada in 1896 (including eight electric railways and bridge and tunnel companies) 21 have been amalgamated into the Canadian Pacific system and 25 into the Grand Trunk system; the remainder are more or less combined. The public has frequently recommenced the Sisyphean labor of forcing railroads to compete. The Ontario & Quebec was constructed at great expense to compete with the Grand Trunk, and the province of Manitoba spent fully $600,000 to make the Northern Pacific enter into a competition with its northern rival. But war has ended in peace, competition has been short-lived, and the truce that invariably ensued led to an agreement of some sort, if not to actual consolidation.

The Grand Trunk is a notable example of this process of amalgamation. Lying within the fertile peninsula bounded by Georgian bay and Lakes Huron, Erie, and Ontario, it has successfully acquired, by lease or purchase, property after property, until its length has increased to 4,186 miles. It is becoming increasingly an American line, obtaining foothold in Michigan, Indiana, Illinois, Maine, Vermont, etc., and having recently obtained complete control of the ill-starred Vermont Central.

What the Canadian Pacific is to the western provinces and the Grand Trunk to Quebec and Ontario the government railways are to the maritime provinces, New Brunswick, Nova Scotia, and Prince Edward's Island. As political and military exigencies dictated its futile policy of building the Canadian Pacific, so the government ownership of the Intercolonial and Prince Edward's Island railways was determined by similar conditions. As early as 1832 it had been proposed to build a line connecting Quebec with the sea-coast towns of Nova Scotia and New Brunswick, and, after a survey in 1835–37, the oppor-

tunity of constructing this important line seemed to have come. But the course of the proposed railway would have led directly across territory then claimed by, and subsequently awarded to, the United States, and the railroad, as finally constructed in 1876, followed a circuitous route, in order to skirt the northern boundary of Maine.

In consequence of this wide detour, which was justified on military grounds, the Intercolonial railway is a needlessly long and uselessly expensive line. Its present length is 1,189 miles, including a short line (Windsor Branch), which is operated, but not owned, by the government. While the government has already expended more than sixty millions of dollars upon this unfortunate railroad, the road, since 1872, has been operated at an annual loss ranging from $26,000 to $954,000. The financial failure of the Prince Edward's Island Railway, the only remaining government railroad enterprise, has been perhaps even more disastrous, this road having been operated at a deficit from the beginning. These results, however, may not be used as arguments either for or against governmental management of railroads. Though financially a failure, the State railways of Canada have been in many ways a success. They have helped to join the eastern provinces in a strong political union, to create a traffic with Quebec and Ontario, to foster a feeling of solidarity, and to be serviceable to the country in the deplorable event of an American or oriental war. The nation stepped into the breach where private capital hesitated, and the millions that have been spent have not necessarily been wasted.

The financial success of a railroad, or of a system of railroads, depends upon the relation that the excess of revenue over operating expenses bears to the total cost of the line. A railroad may be successful because its gross receipts are large, or because its working expenses are small, or because its capitalization is low, or through a combination of some or all of these circumstances. The net income of a railroad may be large, but where, as in the United Kingdom, the capitalization is very heavy, the net revenue per dollar of invested wealth is small.

In new and sparsely-settled countries, the railroads are usually capitalized at a low figure. In the United States the capitalization is considerably heavier in the east than in the less populous west, and the same relation obtains between western Europe and the more sparsely settled countries of the east. The capitalization of Canadian railways is $52,000 a mile, which is less than that of United States roads ($59,610) and considerably less than that of roads in many European States. The capital account per mile of railroad in England is about five times, in Scotland more than three times, in France

and Belgium more than twice, and in Germany, Switzerland, Holland, and Italy from once and a half to twice, as great as in the dominion of Canada. This low capitalization is due not only to the sparseness of the population, but to the comparative youth of the Canadian railways. The capital account of British railways increased from £24,630 in 1838 to more than £47,200 ($235,000) in 1895, but this has been largely due, as in other countries, to the tendency of the railroads to branch out into industries other than that of transportation.

The chief cause of the low capitalization of Canadian railways is the obvious one of low cost of construction, but cost and capitalization are not quite identical. In Canada, as elsewhere, the capital account has been swelled to larger proportions by the facile expedient of stock-working. When the Manitoba & North Western went into receivership, it was bonded to from fifty to one hundred per cent. above its cost of construction. The second issue of Canadian Pacific bonds was made at 25 per cent., and a subsequent and still larger block was sold at 52. There is a natural tendency for the capital account of all corporations to approach, not the actual investment of capital, but the real value of franchise and other property; thus the inflation of railway property for the purpose of concealing profits, or from less laudable motives, has obscured the actual cost of constructing the railroads. In the absence of trustworthy statistics, however, we may still infer that the cost was not excessive. The right of way, which in thickly-settled districts is costly, and on which the English railways, according to a moderate estimate (that of Jeans), expended fully one-tenth of their total capital, was obtained in Canada cheaply, if not *gratis*. The vast sums often expended on palatial stations, on terminal facilities in great cities, in avoiding grade-crossings, etc., were not demanded by Canadian conditions. In the United Kingdom immense sums have been spent in promoting and combating parliamentary legislation, and drains have been made upon the resources of the railroads by all forms of legal and extra-legal extortion. On the other hand, many of the raw materials of construction have been dearer than in Europe, and the Canadians have only partially pursued the policy of substituting cheap alien for the dearer native labor.

A final cause of the low construction cost of Canadian railways is found in the character of the lines. In Canada, as in the United States, there has been in the character of construction a wise adaptation of means to ends, and cheap, light, single-track lines have been built, instead of the heavier and more durable track, in more populous districts. As traffic increased, the light structures have been perfected and supplemented; steel has taken the place of iron, and even of wooden, rails, and the permanent way and rolling stock have

been generally improved. But the railways of Canada are still far more lightly constructed than those of the United Kingdom, or France, or Belgium, owing to the smaller amount of traffic.

The bulk of this traffic is freight, the receipts from this source amounting to 64 per cent. of the total income in 1897, while only 9.4 per cent. were derived from mail, express, and miscellaneous sources, and but 26.6 per cent. from the passenger business. The preponderance of the freight traffic, achieved in spite of water competition, is due to the sparse population and the large area, distance acting considerably less as a deterrent to freight transmission than to travel. The passenger traffic of Canada has grown very slowly. While the tonnage moved, per head of population, increased 194 per cent. (from 1.60 to 4.73 tons) from 1876 to 1896, the number of travellers increased only 106 per cent. (1.40 to 2.88) during the same period. While the Canadian thus averages only 2.9 trips a year, the average in the United States is 8.2, in France 9.1, in Germany 10.4, in Belgium 14.7, in the United Kingdom 24.4 (excluding season tickets), and an almost equal number in the New England States. If the length of the trip is taken into account, the statistics of travel are not so unfavorable to Canada, since in all rural, and particularly in thinly-settled, districts (Russia, Norway, Hungary, Roumania, and the western States) the average distance covered by a traveller is generally great. Like the English railways, those of Canada do not as a rule give statistics of passenger-mileage, but a rough calculation gives the average trip as about forty miles. On the Canadian Pacific each traveller is carried 46.5 miles, and the rate per mile is 2.74 cents. If this fare obtained throughout the whole of Canada, the average distance travelled would not be far from 33 miles, but, despite the high fares in Manitoba and the northwest, where four and five cents a mile are not unusual, the average receipts per passenger-mile are probably less. On the assumption of 40 miles per passenger, the average yearly travel *per capita* equals only 116 miles in Canada, as compared with 153 in Germany, 170 in France, 208 in the United States, and about 250 miles (est.) in the British Isles. With three-fourths of Belgium's population, three hundred times its area, and six times its railway mileage, Canada carries but fifteen million (14,810,-407) passengers compared to little Belgium's hundred million,—a difference only partially compensated for by the smaller *parcours* (about 13 miles) on the Belgian railroads.

Since 1885 the passenger traffic has increased more slowly than the railway mileage, and from 1890 to 1895 it has remained almost at a standstill, but an increase of 15.6 per cent. in the traffic from 1895 to 1897 indicates a coming revival in the passenger business.

The freight traffic has also recovered from the ill effects of the business depression of recent years; but, despite the recent increase in traffic, the total earnings per mile of road have steadily declined. In 1875 the receipts per mile of road were $4,033; in 1880 they had sunk to $3,418; in 1885, to $3,175; in 1895, to less than $3,000. This decline, which may be paralleled elsewhere, is due partly to the construction of new and temporarily unremunerative railways, and partly to the great decline in freight charges, which has been so striking a feature of American railroad history. The receipts per ton-mile on the Canadian Pacific declined from 1.50 to 1.17 cents from 1889 to 1896, and numerous other instances of cheapened transportation might be cited.

The result of comparatively low rates and sparse population has been diminished receipts per mile, the statistics for Canadian railways showing but $3,107 in 1896 compared to about $7,000 in the United States, $11,000 in France and Germany, $12,000 in Belgium, and almost $24,000 in England and Wales.

Fortunately the operating expenses have declined still more rapidly. During the twenty years ending with 1895, the operating expenses declined from $3,268 to $2,049, and, while the working expenses formed 82 per cent. of the total revenue in 1876, the proportion had sunk to 69 per cent. in 1896. Despite this decline in the coefficient of exploitation, however, the net earnings, $15,500,000, furnish but a very moderate return, 1.72 per cent., upon the total paid-up capital, including the government subsidies.

The Canadian railways have passed through a storm and-stress period that has been accentuated and aggravated during the last few years. The slowly-returning prosperity of both the United States and Canada promises to aid the railroads of Canada, and railroad securities have risen, with increase in railroad profits. The suspicious decline in operating expenses within the last few years has occasioned a slight scepticism as to the actual extent of the increasing prosperity of the railroads, and pessimistic views are held in London and elsewhere concerning the ability of such roads as the Grand Trunk to weather future storms. It seems probable, however, that the future progress of the Canadian railroads will be continuous, if not rapid. The bright promises of twenty years ago have not been realized; population has increased slowly, and the great country to the south has robbed Canada of its immigrants. But the Canadians have built for the future, and the development of Manitoba and the west and the increase of manufacturing in Quebec and Ontario, coupled with a conservative railroad policy, doubtless will improve the railway conditions in Canada.

EFFECTIVE SYSTEMS OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

THE METHODS OF A SUCCESSFUL MACHINE-TOOL WORKS.

MACHINE tools occupy a place of so large importance in modern industrial enterprise, and their manufacture involves in itself so many diverse, but closely dependent, operations, that the exposition of a system which has proved efficient in recording the cost of machine-tool building possesses peculiar interest.

Bement, Miles & Co., of Philadelphia, Pa., U. S. A., to whose courtesy is due the information embodied in this paper, are widely known as builders of an excellent line of medium and heavy tools.

Their establishment is complete within itself, making its own castings and forgings, and the shop accounts treat the establishment as a unit, there being no separation of the foundry and forge shop from the machine shop or selling department.

The subject of cost-keeping has been a matter of vital interest as well as careful study to the management, and especially to Mr. Clarence Bement, and has been approached with full recognition of the great difficulties which lie in the way of really accurate cost determinations.

The result of this exhaustive knowledge of cost-keeping conditions has been the introduction of a system intended to recognize, so far as possible, the accurate costs of all details of machine-tool building. Any widely inclusive system must of necessity involve a great number of divided accounts, and a vast amount of clerical labor, some of which may be avoided by the lump-sum methods of less minutely subdivided cost-keeping systems.

The Bement cost-system includes every expense item which can possibly be classed under that head. Interest on realty, interest on machinery, tool-depreciation on a basis of final extinguishment of values, and, in short, all those items of expense which, as has been previously pointed out, are disputed by some manufacturers, are included in the Bement and Miles expense account. Small tools, foundry flasks, patterns, jigs, templets, and special tools are divided in the accounts, a part of each going to assets and a part to expense.

No detail of these percentages of divided accounts need be given, as the ratio of division is an assumption at best, varying with the judgment of each manager. For instance, in the important item of wooden patterns for foundry use, accuracy demands an accounting

with each set of patterns made. A set of patterns for a popular, quick-selling, regular tool is in almost constant use, and is a valuable money-earning asset, while the patterns for a specialized modification of the same tool, used but seldom, and having to go to the pattern shop for extensive repairs each time they are used, as a result of long idleness in the pattern storage rooms, are an expense only, both for first cost and idle storage. And the case is the same with all special tools and fixtures, the values depending solely upon frequency of use, so that anything in a machine shop may fall into the asset or expense account. If used continuously in productive operations, any tool whatever becomes a producer and a valuable asset, laid upon a shelf until required for its infrequent handling, any tool or fixture is an expense instead of an asset, and should be charged into the special expense account made against the machine for which it was first built. But again, suppose a special tool is built for a new special machine under construction, and is charged to the special expense account of that machine and paid for in the selling price. Suppose, further, that this special machine unexpectedly finds large sale, and so becomes standard, and hence in regular manufacture; then all the special tools and fixtures made for it and charged as expense to the first production and paid for become valuable money-earning assets, which do not appear in the inventory, their inventory value having been extinguished by original charge to the special machine expense. Problems of this sort constantly appear in factory cost-keeping, making absolute accuracy impossible; indeed, they make any attempt in the direction of minutely detailed correctness a mere source of clerical confusion. Patterns for foundry use form, perhaps, the most obvious stumbling-block in this direction. They are very costly and very bulky, and demand the utmost care in storage to make them keep their shape and so not utterly destroy themselves through mere idleness. At the Bement works to-day one large building is filled with patterns by far the larger portion of which can hardly be said to be in regular use; and in the present busy condition of the shops this building could very profitably be used for other purposes, and made a productive area, instead of an unproductive harborage for idleness. Who can tell with any degree of accuracy what the expense totals of this pattern storage building really are?

It is such cases as these which apparently justify the lump-sum expense-estimating methods adopted in some thoroughly successful cost-keeping systems, and which deprive of value the detailed records of the percentages of divided accounts. All the conditions are special in each instance, and only the general information that this or that account is divided between assets and expense, or is credited wholly to

one or charged wholly to the other account, can be of any value to the manufacturers at large. On this point it is enough to say that the Bement and Miles theory of manufacturing expense formation is founded on the obviously correct assumption that every expenditure, of any nature whatever, is an indebtedness which must be carried on the books until cancelled by actual payment in cash. There is no juggling with realty under the fiction of "original investment," no carrying of antiquated tools at full price on the inventory because they are constantly repaired and kept up to their original efficiency, and, in short, no diminishing of the expense account by any fiction whatever. Anything which cost money is indebted for that cost, until it is paid for in cash.

Labor is paid in the Bement and Miles shops mainly at piece-rates, and the piece-rates are subject to adjustment. There is considerable day-pay work, also. Workmen's time is kept by a time-keeper at the single entrance and exit, who gives an individual numbered brass check to each hand as he enters the works, and takes it up again from the workman as he leaves the shop. The weekly pay-roll is made up from the time-keeper's time-account as evidenced by the giving out and return of the workmen's individual brass checks. This weekly pay is in full for the day-pay hands, and at a fixed day-rate for the piece-hands, whose piece-rate earnings are audited once in two weeks, the worker being paid the difference between his total earning and the weekly payments he has received.

Work goes into the shop on an office order to the drawing-room. The drawing-room order-card—size, 2½ inches × 3¼ inches—is printed on only one side, and is reproduced below.

A.

Ordered, _____ Del. _____

Symbol, _____ Finished,

Gen. dw'g, _____

Details, _____

Forgings, _____

Alter'ns, _____

Bolt Card, _____

Diagram, _____

This order insures the transfer of the needful drawings and specifications to the heads of departments.

The day-worker's time is kept by the workmen on individual time cards ruled for seven days' work, as per sample given below. The time given on these cards is checked by the time-keeper from his brass-check record, discrepancies between the two being not un-

known. The size of the day-rate worker's card is 3½ inches × 5¾ inches, printed on one side only. In the example given below the first two lines are filled out.

No. *100.* Date, *April 6th*, 1898.

TICKET No.	HOURS.	DESCRIPTION OF WORK. SYMBOL.	MACHINE USED.		
3058	*10¼*	*2 P Q* *220-221*	✓		

☞ Enter your day's work on lines above, and drop slip in Time Box BEFORE LEAVING each night. No time allowed except on slips in Time Box.

The piece-worker's contract card has spaces for forty-six separate entries. These cards bear consecutive numbers, and are torn from a duplicate-stub book. As will be seen, each of these piece-rate cards forms a complete document by itself. The size is 3 inches × 5 inches, printed on both sides, as shown on opposite page.

The screw-room card is spaced for seven days' entries.

The screw-room forms a distinct feature in the economy of the Bement and Miles establishment. It has always been the policy of these shops to use young labor in the form of a full complement of apprentices. As a consequence, there are many applicants for apprenticeship who are under the desired age of seventeen years. From these juniors the screw-room force is recruited. A boy of promising appearance is told that he is too young to enter as an apprentice, but that he can go into the screw-room, and, if his conduct there is satisfactory, he will be made an apprentice as soon as he is old enough. The screw-room machine equipment embraces turret-machines and the usual screw and stud finishing machines, and the boy's year or so of probation in the screw-room is advantageous both to himself and to the shop. Apprentices receive careful attention in these shops, and very quickly become useful.

The screw-room time card is printed on one side only, and is reproduced opposite. Its size is 3⅜ inches × 5⅝ inches.

KEEP THIS CLEAN.

No. 3458 W _____ 189 | Price. _____

Please do the following work on conditions printed on back. **Charge time correctly to above number and letter, and return ticket to your Foreman as soon as work is completed.**

_____ _____

_____ _____

_____

_____

_____

_____

Approved by _____ _____ 189

ENTER TIME HERE.

DATE	HOUR																							
HOUR	DATE																							

Conditions of this Contract.

The person accepting this contract agrees to complete the work specified to the satisfaction of the Foreman and for the amount named in the contract.

Only such work as passes inspection will be paid for, and then only at the time regularly appointed for such payment.

No allowance will be made on account of bad materials or for defective workmanship in any previous part of the work unless pointed out to the Foreman **as soon as discovered and sanctioned by him on face of the ticket.**

SCREW ROOM CARD.

Dept. No. _____ _____ 1898.

Name _____ Check No. _____ Tool No. _____

Chg. _____ Lot _____ Job _____ Drawing _____ Piece No. _____

DAY	TIME		NAME OF PART AND HOW MANY	WHAT DOING
	Over	Regular		
Sunday				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				

There is always considerable job work—"small orders"—in pro-

gress at these shops. The job order goes to the heads of departments on the card order given in blank below. The card is 4⅛ inches × 5½ inches in size, and is printed on one side only.

BEMENT, MILES & CO.

Job..... 189

For.....

.....

.....

Shipped..... 189

Piece-rates at the Bement and Miles shops are fixed by a piece-rate clerk, by consultation and from previous records.

Hour-rates are fixed for all machine tools used in job work, but no account is taken of tools used on shop, day, and contract work.

The total labor payments are used as a divisor of the total expense for the last year, to obtain the expense percentage to be added in order to arrive at the total cost for the current year.

The workmen's cards or time tickets, previously given, are merely blotter charges, from which day-book, journal, and ledger entries are duly made, separate accounts being kept with all machines in regular manufacture.

In point of detail and comparison and cross-checking the Bement and Miles cost-keeping system is very full, and demands a corresponding amount of clerical labor. As has been pointed out, there is absolutely no limit to the subdivision of cost-keeping accounts. Between the single solitary cost-card which contains the whole of the Strieby and Foote cost-keeping books, as detailed in the previous paper of this series, and the elaborate set of books kept by Bement and Miles there is certainly a very great and striking difference. But there is an equally great and striking difference in the conditions of manufacture in the two establishments. In the Strieby and Foote drop-forging shops the entire round of operations does not vary much from those required to produce only the simplest pieces made in the Bement and Miles smithy. Machine-tool manufacture is perhaps the most complicated of metal-working industries classed as a single vocation. In reality machine-tool building embraces invention of a high order, founding, smithing, machine-finishing in all its many branches, painting, preparing for shipment, and all the mercantile details of the selling department. Hence the possibility of Strieby and Foote's single piece of printing to hold all accounts, and the necessity of the elaborate system of bookkeeping by which the costs are found and kept in an establishment like that of Bement, Miles & Co.

MILLING THE GOLD ORES OF THE WITWATERSRAND.

By H. H. Webb and Pope Yeatman.

THE mill, in Witwatersrand practice, is but the first stage in the general metallurgical process, preparing the ore not only for its own treatment, amalgamation, but for the second step, the cyanide process; for it must be remembered that, but for the cyanide process, a very small percentage of the mines on the Rand would pay, and that the industry as a whole owes its salvation to this method of gold-extraction.

There are no very difficult problems in the treatment of the Rand ores. The gold is found in a conglomerate consisting of quartz pebbles cemented together by a siliceous filling, which near the surface is impregnated with oxide of iron, and, below the zone of oxidation, with iron pyrites. The absence of base metals renders the treatment by amalgamation, supplemented by cyanide, extremely simple from a metallurgical point of view, and to this fact is largely due the wonderful development of the cyanide process on the Witwatersrand.

To examine the question of milling alone without considering the subsequent cyaniding of the tailings would produce a false impression, conveying the idea that the stamp practice on the Rand, in percentage of gold extracted, compares unfavorably with that of California or other places. The object is to get the greatest extraction at the least cost, by combining the two processes, the tendency being towards a high crushing capacity rather than a high extraction by amalgamation at the expense of crushing, relying on amalgamation for a fair percentage of the catch, and increasing the extraction by the subsequent cyanide treatment. In other words, the tendency is to make the stamp mill more of a pulverising machine than an amalgamator.

While it is usual on the Rand to amalgamate in the batteries, less attention is paid to the practice than is common elsewhere. The easily amalgamated gold is caught on the outside plates, and the more refractory portion is treated by cyanide. Coarser crushing would be the rule, were it not necessary, in order to secure the best results in cyanide treatment, to have the ore crushed fine. If the crushing is too coarse, very fine gold becomes locked up in particles of quartz or pyrites, and the cyanide solution has but little opportunity to act

upon it. It is not to be understood from the above that amalgamation is neglected, but only that higher yield in the mill is sacrificed that a greater profit may be made through a greater output, reduced costs, and possibly greater combined yields. The good manager endeavors to so combine the two processes as to get the greatest extraction at the least cost.

The first mill, a battery of 5 stamps, at which any of the banket of the Witwatersrand was crushed, was erected in 1885 by Messrs. H. W. & Fred Struben, about ten miles from the place where Johannesburg now stands, for the purpose of working quartz reefs. The following year several samples of conglomerate were crushed, the highest yield being 8 dwts. per ton. Mr. H. W. Struben, in an interesting letter dated January 17, 1893, says: "We milled conglomerates from Vogelstruisfontein, both for ourselves and for others, at our private mill, long before any one else had a mill."*

In April, 1887, the Jubilee Company completed the erection of a three-stamp battery. These were probably the first stamps operated on the Witwatersrand itself. The *Diggers News*, speaking of the event at that time, said: "The machine is kept going during the whole twenty-four hours, and the manager calculates on being able to get through five tons of ground per day, and to have a steady monthly return." "Room is left for another five stamps to be added to the battery."

In May of the same year the Wemmer Company completed the erection of five stamps of their ten-stamp mill; and in August the Witwatersrand (Knights) Company had in place 50 stamps of their 100 head, each weighing 750 pounds.

The State mining engineer's report for 1896 gives the number of stamps for that year on the Witwatersrand at 4,291, and the number of tons crushed at 3,980,682, the yield being £5,346,527, or an average of 26.36 shillings per ton. Including treatment by cyanide and chlorination, the total yield was £7,781,845, or 38.95 shillings per ton, and the average duty per stamp per twenty-four hours 4,392 tons. Eight hundred and sixty stamps have been dropped since 1896.

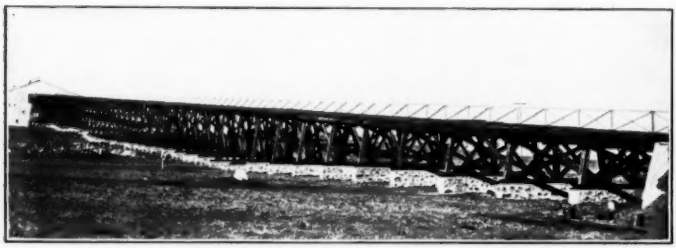
There are few mills of less than 60 stamps on the Rand to-day and those of 100 and more are in the majority. The tendency of the newer mills, for large claim area, is toward 200 stamps, those of the Crown Deep, Rose Deep, Nourse Deep, Jumpers Deep, and Robinson Deep having this end in view, while the new mill at the Simmer & Jack Proprietary Mines, Limited, has 280 stamps erected and in place, and the combination mill of the Anglo and Dreifontein

* "Diamonds and Gold in South Africa," by T. Reunert.

60-STAMP MILL, NOURSE DEEP.
Stamps grouped by tens.

Con. mining companies, now nearing completion, is to have 220. The older mines on the outcrop have mills with 60 to 160 stamps.

Contrary to the practice in mountainous countries, the mills are seldom built on hillsides, so that the advantages of gravitation are not enjoyed. With few exceptions, the ground where the mills are situated is comparatively level, and the ore has to be drawn up an incline to the ore-bins, or, more rarely, raised by means of elevators.



A MILL APPROACH. DREIFONTEIN-ANGELO.

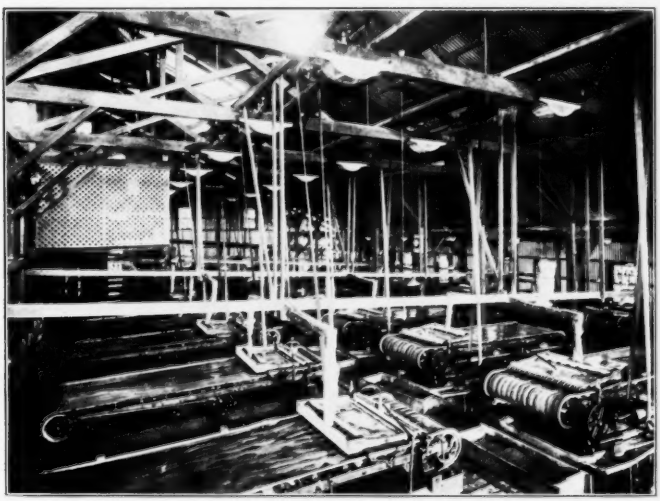
In the more recently constructed mills of the Rand the "banket" is delivered into the mill, after having been sorted and crushed, either at a central station or at stations at the shaft's mouth, and is fed from the ore-bins, by mechanical feeders, to the stamps, where, in the majority of the mills, a preliminary amalgamation takes place in the mortar box. The pulp flows over copper plates for further amalgamation, and in a few instances is delivered to frue vanners for concentration, the tailings going to the cyanide works; but the general practice of the Rand mills is to deliver the pulp direct from the amalgam plates to tailing wheels, or, sometimes, to pumps, to be elevated to the height necessary for the requirements of the cyanide plant, a rough concentration by means of spitzluten being, as a rule, the first step preliminary to the cyanide treatment. Where frue van-

SORTING AND CRUSHER HOUSE AND MILL APPROACH, NOURSE DEEP.

ners are employed, it is customary to use three for every five stamps, but, because of the heavy duty per stamp, they are often overloaded. The product from the vanners, being generally pyrites of high grade, is subjected to chlorination for the extraction of the gold.

The mills are almost invariably placed near the mine rather than near the water-supply. The building itself is framed with timber and covered with corrugated iron. Good foundations are put in, and the construction of the building is very strong. The timber is generally Oregon or pitch pine.

Ore Bins. These are placed on strong masonry foundations, and are made of heavy timbers, well bolted together, the bottoms of the



FRUE VANNERS IN THE WEMMER G. M. COMPANY'S MILL.

bins sloping towards the batteries at an angle of from 40° to 45°. In a few instances, as at the Simmer and Jack and the New Crœsus, flat bottoms are used. Bottoms and sides are usually made of double thickness of 2-inch or 3-inch planks, with a lining of sheet iron. These bins hold from a day's run to four days' run.

Feeders. The use of the "Hendey Challenge Ore Feeder" is practically universal. There is no feeding by hand anywhere.

Mortar Boxes. These resemble the homestake pattern, the main differences being in the height of the feed opening and in the length and width of the boxes. Fraser and Chalmers and the Sandycroft foundry have supplied most of the batteries. As the stamp mills on the Rand

SIMMER & JACK STAMP MILL.
Stamps grouped by twenties.

are rather larger than the average, the mortar boxes, too, are larger and of greater thickness. At the issue the boxes vary between 11½ inches and 18 inches. Most of the mortars have heavy cast-iron or steel linings in the front, back, and sides of the boxes, to insure a longer life. Below the dies false bottoms of cast iron are put in. Several thicknesses are often employed, to insure uniformity of depth of discharge as the dies wear down.

The mortars are placed on piles 12 to 15 feet in length, which rest on 1½ to 2 feet of concrete. The piles consist of heavy pine timber about 14½ inches square, and are bolted together firmly, both lengthwise and crosswise. The pile pits are excavated to hard rock, where possible. The walls of the excavation are built of heavy masonry or concrete, and the space between them and the mortar blocks is filled either with sand, or with tailings well rammed, or with concrete. Between the mortar block and mortar is placed a thick sheet of rubber or, occasionally, felt. The boxes are held down by eight bolts about 1½ inches in diameter, which at the lower ends are recessed into the wooden piles and are held by cotters. They are tightened by nuts on their upper ends. There is plenty of clear space about the batteries, and all bolts can be easily reached.

Screens. These are of well-woven iron or steel wire. The meshes range in number between 500 and 900 to the square inch, 700 be-

ARRANGEMENT OF FRUE VANNERS IN GEORGE GOCH MILL.

ing very common. The area of the holes ranges from .004 to .007 of a square inch. The life of the screen is very short,—between two and three days on the average.

The height of discharge in a battery is regulated by the use of chuck blocks as the dies wear down, or by having several sets of screens, which may be inserted from time to time. The width of the lower sides of these varies. The custom is to employ from two to three chuck blocks. There is a considerable variation in the height of the discharge. When amalgamation in the battery is considered an important feature, the discharge is raised; where rapid crushing is considered of more importance, a lower discharge is employed.

Stamps, Shoes, Heads, Tappets, Dies. The first stamps employed on the Rand were considerably lighter than those favoured at present. Stamps weighing from 750 to 850 pounds, the other parts being light in proportion, were used at first. In all the batteries now being erected, and in those that have been built within the last year and a half, the tendency is towards very heavy stamps, the weight varying between 1,100 and 1,250 pounds. The mills being erected under the supervision of the Rand Mines, Limited, have stamps averaging about 1,150 pounds; those erected at the Simmer & Jack and at the Robinson Deep weigh nearly 1,200 pounds. Even with the old style of stamps, by adding extra tappets or putting in heavier heads, the weight has been increased, and, in consequence, the crushing capa-

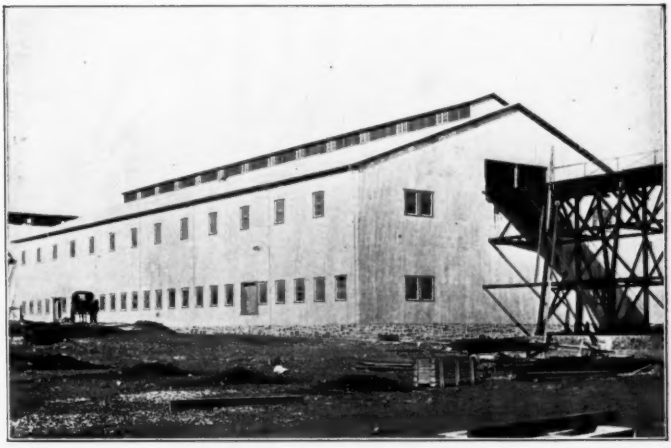
city. According to the State mining engineer's report for 1896, the average weight of stamps was 973 pounds. In order to equalize the weight, it is the custom in some mills to use in one set of batteries heavy heads, and in another set lighter ones. New shoes are placed first in the second set, which, after being worn, are taken off and placed in the first. By this means the light heads always have the heavy shoes, and the heavy heads the partly worndown shoes.

Shoes, Heads, Dies, Stems. Shoes are made of various varieties of steel, such as Chrome, Hadfield's Manganese, Firth's cast steel and

ORE-SORTING FLOOR, FERREIRA GOLD MINING CO.

forged steel, etc. They range in weight from 180 to 240 pounds. They are 8½ to 9 inches in diameter, and in height 9 to 12 inches. Heads and tappets are made of cast steel, the former weighing from 260 to 365 pounds and the latter from 106 to 130 pounds. Dies are 8½ to 9 inches in diameter and 6 inches high from the top of the 1-inch hexagonal bottom. They are made of Firth's, Hadfield's Manganese, or forged steel. Stems are tapered at both ends, and are made of faggotted iron. They range in weight from 350 to 475 pounds, and in diameter from 3¼ to 3¾ inches.

Batteries. It is customary the world over to have five stamps to a battery. On the Rand two batteries are usually placed together, with a clear space of five to six feet between them and the next pair, each battery having its own cam shaft and separate driving-wheel.



DREIFONTEIN-ANGELO 220-STAMP MILL.

In some cases one cam shaft and one driving-wheel serve for ten stamps. At the Simmer & Jack four batteries are placed consecutively, with two driving-pulleys and two cam shafts. The plan of having one driving-pulley for each five stamps is favoured by the mill men, as the delays occasioned by necessary repairs affect a smaller number of stamps at a time. Cam shafts are made of faggotted iron, and range from 5 to 6½ inches in diameter.

Cams. Cams are made of cast steel, and vary somewhat in design and in the manner in which they are attached to the shaft. The Blanton cam is deservedly popular; there are no keys, the cam being fastened to the shaft by means of a circular wedge, which is prevented from slipping by the short pins dropped into recesses in the cam shaft. This causes great saving of time in attaching cams and in replacing broken cams on the shafts. The George Goch has introduced for trial on one battery a cam which, instead of having a circular opening, has a decagon fitting on a cam shaft of the same section.

Drop and Speed. The drop of the stamps ranges from 7 to 9 inches, the average being about 8 inches. There is, perhaps, less variation in speed, this running from 92 to 104, the average being about 96.

The order of drop is usually 1-3-5-2-4, although 1-4-2-5-3 and some others are employed.

The amount of water used in crushing ranges from 8 to 9 tons, per ton of ore crushed. This does not mean that that amount of

make-up water has to be supplied, as the water is used over and over again, the only loss being due to leakage, evaporation, and absorption by the tailings. This loss, or make-up, is estimated at 25 per cent.

Copper Plates. Apron plates are universally adopted. Inside the

COMPARATIVE TABLE.

MINE.	No. of stamps.	Weight of each stamp.	No. of drops per minute.	Height of drop in inches.	Av. depth discharge in inches.	Crushing capacity per stamp.	Mesh of screen.	Cost of milling.
								s. d.
Bonanza	40	1150	96	8½	4½ to 6	5.43	700	4 3.50
City & Suburban	160	1000	96	7½	5½	5.01	700	3 9.58
Crown Reef	120	956	97	8½	4½ to 6	4.97	700	2 8.13
Ferreira	80	850	94	8½	4	4.38	700	3 4.29
Geldenhuis Estate	120	950	97	8	6	4.75	700	2 5.02
Geldenhuis Deep	200	1050	96	8½	5 to 7	4.38	700	3 2.76
Jubilee & Salisbury	50	950	95	8	4	3.75	600	2 4.00
	50	900	95	8		3.75	600	
Meyer & Charlton	80	1000	94	8	2½	4.34	500	2 9.741
New Primrose	160	1088	96	8	4½	5.28	600	2 8.64
New Comet	60	1050						
	40	1250	96	8	3	4.21	600	3 1.88
Robinson	120	930	97	8½	4 to 5	4.60	800	3 8.34
Simmer & Jack (new mill)	280	1250	95	8 to 9½	6¼ to 7⅜	....	600	
" " (old mill)	100	1000	95	8½	....	4.49	600	3 11.08
Wolhuter	100	1050	95	7 to 8	3½	4.62	500	3 1.842

MINE.		Metal worn per ton of ore crushed.	Cost per ton of ore crushed.	Total cost for shoes & dies per ton of ore crushed.	Loss of mercury per ton of ore crushed.	Cost of mercury per ton of ore crushed.	Life of screens.
		oz.	pence.	pence.	oz.	pence.	hours.
City & Suburban	Shoes	8.10	1.75	2.50	.24	.44	36 to 38
	Dies	3.50	.75				
Crown Reef	Shoes	8.00	1.37	1.97	....	....	....
	Dies	2.80	.60				
Geldenhuis Deep	Shoes	9.42	1.61	2.93	.13	.24	60
	Dies	6.10	1.32				
Meyer & Charlton	Shoes	12.80	2.20	3.11	....	....	....
	Dies	4.20	.91				
New Comet	Shoes	11.00	1.89	3.32	.42	.77	46
	Dies	6.6	1.43				
Simmer & Jack	Shoes	8.48	2.60	2.60	.24	.40	72
	Dies	3.84					

CHAIN SORTING BELT, MEYER & CHARLTON G. M. CO.

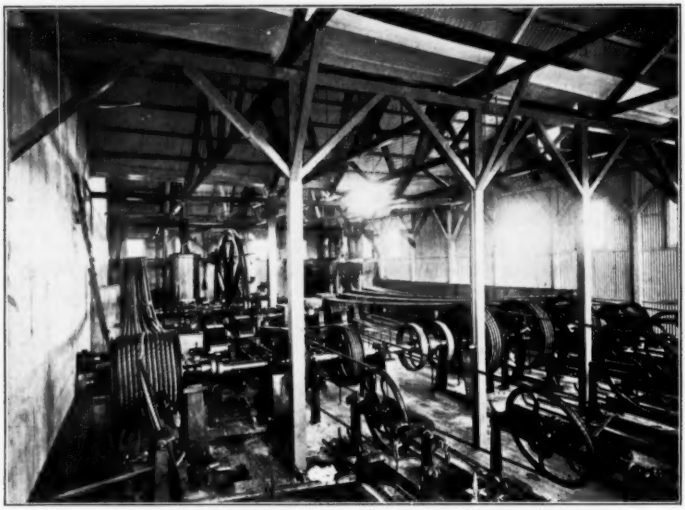
batteries both back plates and chuck plates are used, but the former are the most common. In some mills lip and splash plates are used. Apron plates are from 10 to 12 feet long and from 4½ to 5 feet wide, and incline from 1 inch to 1¾ inches to the foot. Sometimes they are broken, but usually continuous. Back plates are from 7 to 11 inches wide, and chuck plates from 3 to 6 inches. The copper plate used is from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch thick. They are rarely silver plated, and, when a new mill starts up, considerable time elapses before the plates cease to absorb large amounts of gold.

One of the points of great difference in the Rand Mills is in the arrangement of the line shafts. These are either coupled directly to the mill engine or driven by rope-transmission. The latest mills erected by the Rand Mines, Limited, employ direct coupling with the engine at one end. The new Simmer & Jack Mill uses rope-transmission with two line shafts, one for each side of the mill. In the old Simmer & Jack Mill, where the batteries were in line, the mill engine was placed in the middle, with fifty stamps on each side and with direct coupling. The Witwatersrand Mill has the engine in the middle, but the line shaft is driven by rope-transmission. At the Geldenhuis Deep one line shaft is coupled directly, while the second is driven from the first by rope-transmission. Direct coupling works exceedingly well.

Between the line shaft and the cam shaft various forms of belt tighteners are used. In many of the later mills patent clutch pulleys are employed, doing away with the tightening gear.

Mill Engines. Very excellent power installations are the rule. In many instances the engine drives not only the mill itself, but also the tailings wheel, the electric light plant, the electric precipitation plant, the shops, and sometimes the crushers.

Both vertical and horizontal engines are used, but the latter are in the majority. The usual type is the horizontal compound condensing engine with Corliss valves. To avoid delays an auxiliary engine is sometimes installed. This, of course, is a much cheaper engine than

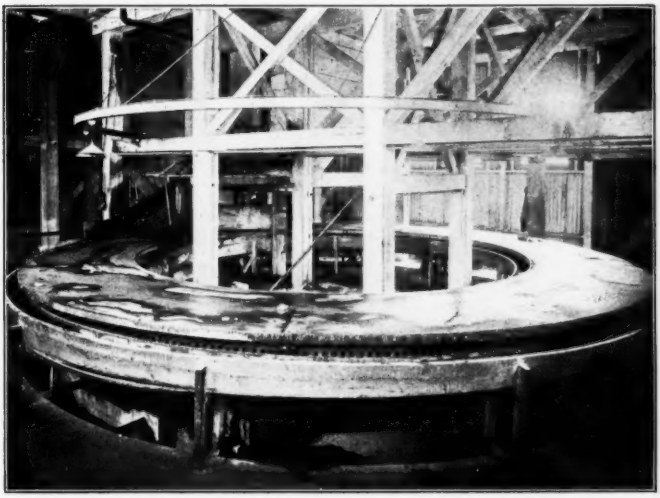


CROWN REEF MILL ENGINE ROOM, SHOWING ROPE DRIVE.

the main engine, and, while not compound condensing, is so made that it can be compounded if desired.

The mills are well supplied with mercury traps made of wood, or, preferably, of iron, and have large and well-constructed launders with ample grades. One or more overhead crawls are used along each line of stamps for the rapid handling of the heavy parts of the batteries. The use of electricity for lighting is almost universal, and the old-fashioned, badly-lighted mill has become a thing of the past.

Clean-up Room. This is well supplied with benches and the usual appliances for cleaning up. A pan, barrel, or batea run by machinery is used for the clean-up from the mortars. During operation the outside plates are rubbed every four hours, and the amalgam removed once a day. The general clean-up is made once a month. The percentage of extraction by amalgamation varies, but the average



REVOLVING CIRCULAR ORE-SORTING TABLE, CROWN DEEP G. M. CO.

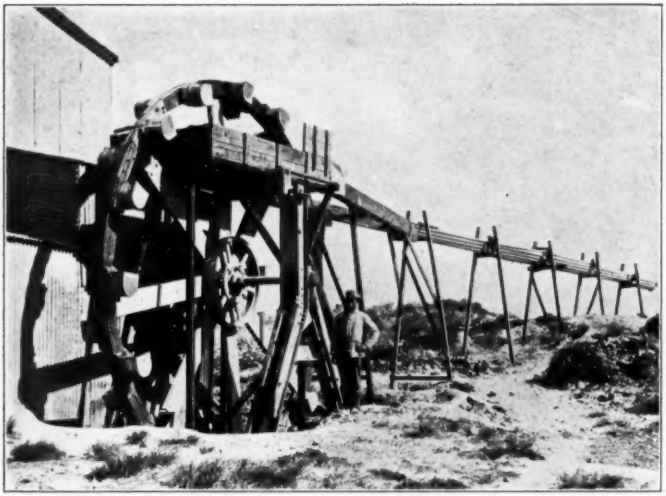
is from 55 to 65. Retorting and melting are not done in the mills, melting being done mainly in the assay office.

Labour. The amount of labour used is considerable, and, where one white man is employed in other parts of the world, at least one white and one native are employed on these fields. The following table shows the labour employed by a mill of 100 stamps:

Labour Employed at 100-Stamp Mill.

4 amalgamators per shift of 8 hours	12
1 engine driver per shift of 8 hours	3
1 blacksmith 9 hours shift	1
1 carpenter 9 hours shift	1
1 fitter 9 hours shift	1
1 hoisting engineer 9 hours shift	1
1 greaser	1
Whites	20
10 natives, assisting amalgamators, shift of 12 hours	20
10 natives assisting mechanics	10
10 natives hoisting and dumping	10
Natives	40

Tailings Wheels. Where lifts of more than 40 feet are necessary,



AN OLD-STYLE TAILINGS WHEEL.

plunger pumps are commonly used. The latter have given good service where the proper arrangements have been employed to apply clear water to the plungers to prevent scouring. However, for lifts of less than 40 feet the tailings wheel is most satisfactory, requiring but little power and little or no attention. These wheels are patterned after those used at the concentration works of the Lake Superior copper mines.

The temperature being so mild, there are no troubles due to freezing. Tailings wheels, launders, spitzkasten, etc., need no shelter.

The mill of the Simmer & Jack Proprietary Mines being the largest gold mill in existence, and a type of modern mill-construction, a description of it is given here: Built on level ground, as are most of the mills on the Rand, the approach to the ore-bins is a raised earthen embankment having a 2½-per cent. grade, over which are drawn, by locomotives, trains made up of trucks of 20 tons' capacity each, which supply the mill with ore from the different shafts of the property, where sorting and crushing have already taken place. The mill building is 269 feet long by 100 feet wide, exclusive of the engine room and boiler house, the frame being of wood covered with corrugated iron.

The ore-bins are rectangular in cross section, the bottoms being flat, and have a capacity of 6,000 tons, or about four days' supply, with the full mill in operation.

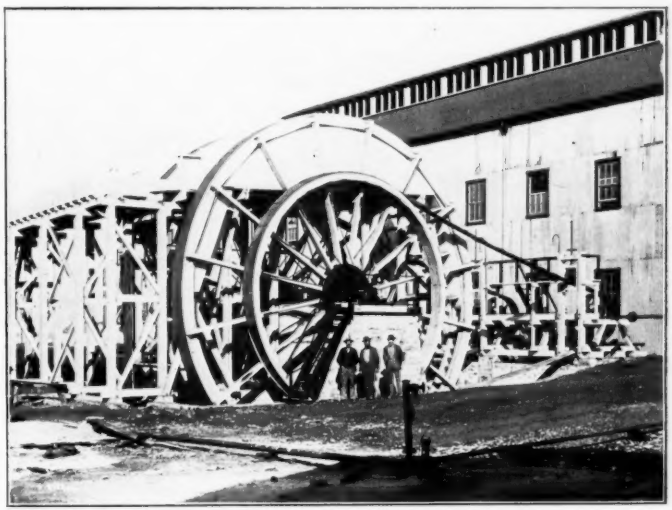
The mortar blocks consist of eight karri wood piles bolted together, and the mortars are 4 feet 10 inches in length by 4 feet 8 inches in height, and are lined with steel. The sides are 1 inch in thickness, and the bottoms 9 inches.

The feed-opening is 3 feet 2 inches above the base, and has a width of 3½ inches for the full length of the box. The height of the discharge is 6¼ to 7¼ inches, and the screens, of 600-mesh steel wire, are 51¾ inches long by 10 inches wide, and have a life of three days, costing .54*d.* per ton of ore crushed. Amalgamation is done entirely on the outside plates or apron. This is a new departure at this property, as at the old mill inside amalgamation was also practised.

The stamps are arranged in groups of twenty, ten being driven by each cam shaft, and weigh 1,200 pounds each, made up as follows:

	Weight.
Shoes, 9 inches by 12 inches.....	221 lbs.
Heads, 9 inches by 18 inches.....	284 "
Stems, 3½ inches by 18 feet double ended	560 "
Tappets, 9¼ inches diam. ends by 13 inches	119 "
	1184 "

The dies are 9 inches by 7 inches, and weigh 140 pounds.



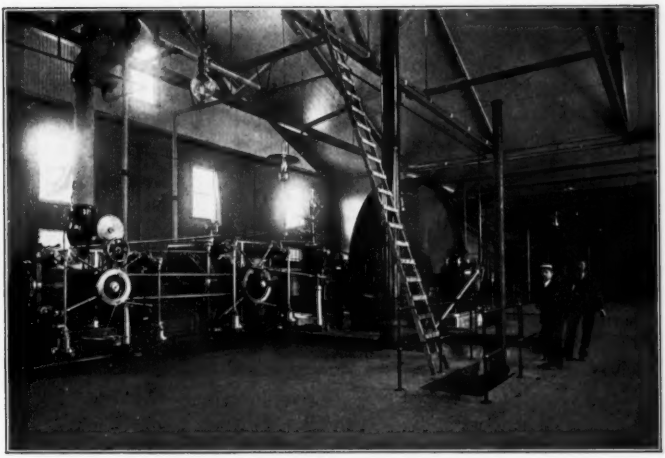
NEW STYLE TAILINGS WHEEL, SIMMER & JACK MILL.

GENERAL VIEW OF THE SIMMER & JACK MILL.

The drop is from 8 inches to 9 inches, and the order 1-5-3-2-4, the minimum of drops per minute being 95.

The cams are of cast steel, and have a sweep the outside diameter of which is 33½ inches. The cam shaft is of faggotted iron with a diameter of 6½ inches, and a length, over all, of 14 feet 3 inches. The cam pulley is of wood, having a diameter of 6 feet and a face of 17 inches. An overhead trolley is arranged under the cam platform

MILL APPROACH, RAND MINES CO.,[?] LTD.



ENGINE ROOM OF THE SIMMER & JACK MILL.

for transporting shoes, dies, etc., to the mortar boxes. The mill has been running too short a time to enable an accurate estimate to be made of the consumption of iron and cost per ton of ore crushed.

The battery tables have an effective surface 16 feet long by 4 feet 7½ inches wide, a fall of 1¾ inches per foot, and are covered with ⅛-inch sheet copper; they are constructed with one riffle 10 feet down from the mortar box end. A mercury trap is fixed at the end of each table. The pulp from the mortar boxes discharges on lip and splash plates before beginning the descent of the tables.

There are two complete steel line shafts, one for each side of the mill, ranging from 10 inches in diameter at the engine end to 6 inches at the tail end. The pulleys for driving the cam shafts are 36 inches in diameter and 17 inches in face. The mill is driven by a compound tandem Corliss surface condensing engine, by Messrs. Yates and Thom, with cylinders 24×44×54, running at 70 revolutions, giving 900 i. h. p. The driving-pulley is 21 feet in diameter, having grooves for 20 1¼-inch manilla ropes, leading on to a pulley 15 feet 6 inches in diameter on the near line shaft, the two line shafts then being connected with rope pulleys 15 feet 6 inches in diameter for 10 1½-inch manilla ropes. Rope-tightening gears are used on both drives.

There are five 200-h. p. Heine boilers with two 200-tube economisers and one steel chimney 100 feet high and 6½ feet square.

The launders in the mill have a 4 per cent. grade, and deliver the

tailings to three 38-feet tailings wheels, to be elevated for delivery to the cyanide works.

Such a gold mill varies but slightly from the general type in California and the west of America. Distinctly different from this in one feature at least, and peculiar to the mill construction of the Rand Mines Company, Limited, is that of the single line shaft coupled directly to the crank shaft of the driving engine,—a style of mill first introduced in the Black Hills of Dakota. Those of this type on the

NIGHT AT A SOUTH AFRICAN GOLD MILL.

Rand are of 200 stamps, or constructed for 200 stamps as an ultimate; for instance, the Crown Deep, Rose Deep, Nourse Deep, Jumpers Deep, etc.

The ore is delivered to the mill from a central sorting and crushing station, by rope-haulage up an incline, to bins of about 2,700 tons' capacity, and fed by challenge feeders to the stamps.

The mortar boxes are Fraser & Chalmers' No. 102, the height from the base being 4 feet 10½ inches, and length over all 4 feet 10½ inches. The average thickness of sides is 1½ inches; of bottom under the dies, 9 inches. The box is lined with steel. The height of the feed-opening is 4 feet 4½ inches above the base, and the width is 4½ inches. The height of the discharge is 8 inches, and the size of the screen 700-mesh with a life of 36 hours. Inside amalgamation is practised.

The stamps are arranged in groups of ten, and one cam shaft serves

each group. They weigh about 1,150 pounds each as follows:

Shoes 9″ × 10″ & 9″ × 12″	Weight	200 to 235 lbs.
Heads 8¾″ × 18″.....	"	245 "
Stems 3¾″ × 15′.....	"	540 "
Tappets 13″ × 9 7/8″.....	"	130 "
		1,150 "

The dies are 9 inches × 7 inches, and weigh 118 pounds, having a smaller base than those of the Simmer & Jack. The average drop of the stamps is 8 inches, and the order 1-4 2-5-3, the number of drops being 96 per minute. The Blanton cam is used. It is made of cast steel and has a sweep 31 inches in diameter. The camshaft is 6 inches in diameter and 14 feet 7 inches length over all. The cam pulley is of wood, 6 feet in diameter with a 16½-inch face.

Tables are of unsilvered copper plates 3/16 of an inch thick, and have an effective surface of 12 feet by 5 feet, with a fall of 1¼ inches to the foot, there being one mercury trap to every two tables. The launders from mill to tailings wheel have a grade of 3¼ to 3¾ per cent. The pulp is elevated to the cyanide works by means of one 46-foot double-bucket tailings wheel.

Line Shafting. There is one mild steel line shaft underneath the centre of the ore-bins, coupled directly to the driving engine; the diameter at the coupling is 10 inches, from which it decreases to 9, 8, 7, and finally 6 inches.

The pulleys driving the camshaft pulleys are 54 inches in diameter with a face of 16½ inches, and are fitted with Seymour's patent friction clutch, the speed of the line shaft being 65 revolutions.

The power consists of one main driving engine, a tandem compound surface condensing engine manufactured by the Ingersoll-Sergeant Drill Company. The cylinders are 24 × 44 × 54, running at 65 revolutions, with an i. h. p. of 800. There is also a Corliss auxiliary engine non-compound 28 × 54. This, like the main engine, can be coupled directly. Besides running the mill, these engines usually operate the incline haulage and tailings wheel, and often the electric lights, crushers and sorting tables, and cyanide works. There are eight 106-h. p. boilers, made by Fraser & Chalmers, 16 feet 6 inches long and 4 feet 6 inches in diameter.

These two illustrations typify the best mill construction on the Rand, embodying all the points of modern mill building.

The cost of mill construction on the Witwatersrand may be placed at from £400 to £500 per stamp, depending on the size and design of the mill. As a whole, the mill practice, may be considered excellent, metallurgically and financially.

THE UTILISATION OF BLAST-FURNACE GAS FOR THE PRODUCTION OF POWER.

By W. H. Booth.

THE enormous waste of valuable gas which for years has been going on from the blast furnace has been seen, no doubt, very plainly by more thoughtful men, but no avenue of escape from the difficulty has presented itself until within recent years. The gases were used formerly in their crude state under boilers, for the generation of steam to drive the blowing engines, but this was recognised as only a partial utilisation. In the Scotch furnaces coal is the fuel employed,—not coke, as in England,—and, a few years ago, the recovery of the tar and ammonia was attempted with success, the revenue from the bye-products having been a considerable assistance to the Scotch iron trade. But this residuals-recovery plant still left the principal residual, the gas itself, almost useless, and it was only when Mr. B. H. Thwaite noticed the remarkable similarity between blast-furnace gas and the product of the so-called gas producer that the possibilities of blast-furnace gas became evident.

Producer gas consists of one part of combustible gas to two parts of nitrogen with a small proportion of carbon dioxide. The combustible gas is chiefly carbonic oxide, the remainder being free hydrogen and marsh gas, CH_4. To reduce iron from its oxides a reducing agent is required. This reducing agent is carbonic oxide. How or where formed in the furnace is a matter of dispute. Some aver that carbon at once burns to CO_2 in the presence of oxygen, and then picks up a second atom of carbon, becoming CO. In acting on the iron oxides of the ore and upon the lime flux, a good deal of carbon dioxide is either set free or made by conversion of the monoxide. After passing the zone of reduction, the gases probably contain a considerable percentage of carbon dioxide, and, if the gas could pass off at this point, the furnace index might better please the metallurgists, for it would indicate a better utilisation of the fuel. But above the reduction zone there is more fuel and ore, and the hot gas absorbs more carbon, so that the gases, as they finally escape, are very poor in CO_2 and rich in CO, and possess, therefore, a large store of potential energy.

It was to the utilisation of this that Mr. Thwaite directed his efforts, and he was so far successful that he obtained permission to try

the system at the works of the Glasgow Iron Co. at Wishaw. It was in reference to the writer's tests of this plant that a few figures have already appeared in THE ENGINEERING MAGAZINE, and perhaps more details may be acceptable.

The plant necessary to utilise the gas for power purposes is so very simple that there is not much to be said about it. One goes to see the demonstration plant in operation. A pipe is carried from the gas return main of the residuals-recovery plant. This leads the gas to an exhauster, which forces it forward into a holder through a filter placed to deal with any possible remainder of dust. From the holder the gas passes to the engine, and that is all there is to say or to see, in a general way. Five minutes is sufficient to secure a general grasp of the whole plant. In the demonstration plant at Wishaw an engine of 20 h. p. is employed. This engine is belted to a direct-current dynamo supplying current at about 100 volts. It also drives the gas propeller, which draws gas from the main and sends it forward to the holder.

The plant at Wishaw is not run against a brake,—no doubt a very useful method of showing power to engineers,—but it generates electric current, and this current can be measured and forms a very easy check upon the work done by the engine, appealing to the non-technical man better than a mere power-absorbing brake strap. The current thus generated is employed for lighting purposes. At the time of my test there were ten arc lamps in five groups of two in series; one incandescent lamp of 50 c. p.; 11 incandescent lamps of 32 c. p.; and 68 of 16 c. p.

These lamps do duty at the furnaces, the residuals plant, the offices, etc. Useful and paying work, is, in fact, being accomplished by the first attempt at using the gases. So far from there being anything to suggest experiment, the small plant looks as though it had been installed by a firm of twenty years' experience for its duty of lighting the works. Testing such a plant was not a difficult matter. Blast furnaces are known to produce about 180,000 cubic feet of gas for each ton of coal consumed. In the plant tested the holder served the purpose of a meter. It was supplied with gas through a special valve, which could be instantly changed to direct the gas from the blower, by a bye pass, back to the large gas main, thus shutting off the supply to the holder. The holder was 10 feet in diameter, and therefore held 78.54 cubic feet of gas per foot of length.

By measuring the lowering of the holder in, say, five minutes, the consumption of gas by the engine could be ascertained at once, and, the electrical output of the dynamo being known, the gas consumption per e. h. p. could be ascertained. This is better than using the indicator. The engine employed was of Glasgow make,—the Acme,—

running at a speed of 190 revolutions per minute on the usual Otto cycle. As with all engines using gas of "producer" type, it varied slightly from the engines using rich illuminating gas. These alterations comprise, of course, a varied ratio of the gas and air inlet valves, and a change in the piston in order to secure the best ratio of compression.

The electrical output, when the engine was consuming 28 cubic feet of gas per minute, was 85 amperes at 107 volts,—equal to 12.2 electrical h. p. This corresponds with a fuel-consumption of 1.65 pounds per electrical h. p. on the basis of a production of 180,000 cubic feet of gas per ton of coal used. As the day was hot, and the gas was not cooled down to even atmospheric temperature, the measurement of 28 feet, registered by the fall of the holder, did not really represent a consumption of 28 feet at normal temperature. At the time of my tests the blast furnaces were not working quite regularly, and were producing a poor gas. Previous tests had shown 1 e. h. p. to 1¼ pounds of coal fed to the furnace.

When first proposed, metallurgists were inclined to ridicule the idea that blast-furnace gas is capable of utilisation by the gas engine. In the first place, the gas was full of metallic dust, and, in the second place, it contained too much carbon dioxide to explode properly. The dust difficulty can be disposed of in various ways. In a residuals-recovery plant it is mostly deposited in the dust chamber, the remainder being caught in the scrubbers. Dust may also be thrown down by electrical influence, the dust particles aggregating when electrically charged and more readily depositing. The second objection does not hold good, for not only does the gas engine run with the gas, but no one seems as yet to have noticed any misfires. None occurred during the time the engine was under the writer's observation.

In manufacturing electricity by ordinary means a heavy outlay must be faced in works run by water power. Various water power schemes in Southern California, as detailed in THE ENGINEERING MAGAZINE of March, 1898, show an expenditure on canals, pipe lines, generating plant, and transmission line varying from about $75 to $200 per h. p. If steam be employed, there is a large first cost for boilers and a continuous large expenditure in stoking these, on coal and on water. If producer gas be employed with gas engines, there is the first cost of the producers and their subsequent attendance. With the blast furnace plant these expenses are avoided. The blast furnace is there. It is fed with fuel in the roughest manner, by mechanical means, and even this expense is borne by the primary product of the furnace—pig iron. Thus there is no first cost of steam boilers or gas

producers or water channels. These are represented by the gift of a huge blast furnace, which is an ideal producer of cheap gas and might well be a model for special gas producers. Further, there are no costs for ash removal or clinkering. These products are liquefied in the blast furnace, and are run out by gravity. The blast-furnace plant is thus on a par with water power as regards attendance costs, but does not involve the cost of preliminary works.

The idea may also be looked at from the view point of the iron manufacturer. At present he uses a hot blast, whereby he consumes some of the furnace gas and economises fuel, but he makes an inferior iron. He could dispense with the economy of the hot blast, were he able to sell the gas now employed to heat the air stoves; though this would reduce the production of iron, the product would be of cold-blast quality, and would sell at a higher price, more than offsetting the decrease in volume. Let it be assumed, however, that, after providing for the purposes of the blowing engines and of the hot blast, there remains a fourth of the gas. In America the average output of a blast furnace in 1895 was 712 tons per week. In round numbers the fuel consumed may now be 1,000 tons per week, or 2,240,000 pounds, one fourth of which is 560,000 pounds, or 3,333 pounds per hour. We will base our figures, then, on a furnace which consumes, weekly, one thousand tons of fuel. With one electrical h. p. from each 1½ pounds of fuel-equivalent in the gas, the electrical h. p. of an average furnace, if only a fourth of the gas be used, will thus be 2,222. Assume, however, that a cold blast be decided upon, and that the blowing engines absorb 400 h. p. The total h. p. of the gas will be 8,888, of which 400 h. p.—an excessive estimate—go to the blowing engines, leaving 8,488 available. To heat the blast to 1,000° will demand approximately one-fifth of the gas, or 1,780 h. p., leaving a net 6,700 h. p. available for outside power. An ordinary hot blast has a temperature of 1,000° to 1,200°. The waste gases depart at a temperature of 500°. With suitable arrangements and a prospective economy in view, the blast may be heated first by the cooling of the waste gases, and next, if desired, by the usual brick stoves; or, as suggested, the blast may have a moderate temperature only, being merely heated by the cooling of the waste gas on the counter current system. Probably a power of at least 10 e. h. p. might be regularly and continuously obtained by the consumption of each ton of fuel per week, after providing for the hot blast and for the blowing engines, which, of course, would also be gas engines.*

Having secured the means of converting the gas into mechanical

* For particulars as to weight of air and fuel, and waste gases, see *Trans. A. I. M. E.*, Vol. XIX, p. 959.

energy, the next question is as to the use to which such energy can be put. There are various methods:

(1) To establish factories on the spot,—a proceeding limited to a narrow choice of factories, for not every business could be carried on conveniently at the site of an ironworks, for commercial, physical, and labour reasons.

(2) To transport power to a distance by means of wire ropes, which implies an exceedingly small radius of transmission, representing at most an area of a very few square miles.

(3) A system of air compression, whereby a considerable area could be covered by means of expensive pipe lines and at a loss of 30 to 40 per cent. of the energy employed in the compression.

The hydraulic system would be practicable with perhaps less loss than that involved with the last system, but with a much narrower *clientèle*, and the gas itself might be pumped in a more or less compressed state and used in gas engines at a distance. All these methods have great and obvious objections, and they all retire at once to the background when electrical transmission is suggested. By this, the latest of all systems of power transmission, the waste energy of the blast furnace can already be transmitted one hundred miles with a loss of not more than thirty per cent. In a small country like Great Britain, with about fifteen or more centres of iron manufacture, there are immense possibilities. The textile districts of Lancashire and Yorkshire, Leicester and Nottingham, are all within a few miles of blast furnaces. London itself is not one hundred miles from two small iron centres. Birmingham is close to power, and the immediate vicinity of all the larger centres is full of workshops, tramways, and other power users, not to mention the requirements for lighting purposes.

The blast furnaces of the United States would find more than 2,000,000 continuous h. p. on the above estimate of 10 h. p. per weekly ton of fuel. The estimated cost of utilisation plant and thirty miles of transmission line is less than $60 per electrical h. p.

As regards the qualities of various gases for power production, they are shown by the following result of an analysis of a sample of producer gas, against which is set an average analysis from four blast furnaces, and two from the furnaces supplying gas to the Thwaite plants at Wishaw, near Glasgow, and at Frodingham, near Doncaster.

The proportion of combustible gases is about one-third of the total product. The gas at Frodingham is very poor, but it works satisfactorily in the gas engine.

It may be taken as assured that, when furnace gases shall be generally in demand for power purposes, metallurgists will not experience

	Producer Gas.	Four Blast Furnaces.	Wishaw Furnaces.	Frodingham Furnaces.
CO	22.8	30.76	26.78	27.3
N	63.5	53 60	57.07	65.2
CO_2	3.6	14.44	7.38	6.0
H	2.2	0.50	5.20	1.5
CH_4	7.4	0 80	3.57	.....
O	0.5	0.40	.....	.....
	100.0	100.50	100.00	100.0
Per Cent. Combustible...	32.4	32.06	35.55	28.8

any difficulty in supplying such gases with a minimum of CO_2.

At present a high index or ratio of CO_2 is sought for the sake of economy. Sir Lowthian Bell, who is a leading English authority, gives the higher limit of CO_2 as one-half that of CO. More economical working he does not think possible; in the future the endeavour will be towards the lower index. With gas so useful, it is not probable that it will be given away. Indeed, the possibility exists that gas may become a primary product, relegating iron to the position of a bye-product. Without laying stress upon this view, there may still be entertained the hope that furnaces, now unable to compete, and therefore representing so much dead capital, may be enabled to start up again into active life. Indeed, with a demand for power, a blast furnace may be run purely as a gas producer without reference to its power of producing iron or slag. Slag would be made, if required for road purposes, and it might always pay to manufacture some iron, if only to pay for the limestone necessary for a fluid slag to save expense in clinkering. There is nothing visionary in this. At Wishaw, and now at Frodingham, near Doncaster, the system is in operation. This Frodingham plant is of special interest, because the analysis shows a smaller percentage of combustible gas, and proves that even the poorer gases are available for direct use in the gas engine.

Let us see what authorities on iron production have said about the use of blast-furnace gas. In Bauerman's "Metallurgy of Iron," page 267, we read: "If, now, the consumption of coke be 30 tons per day, the gases, if applied to steam boilers, will, by their combustion, raise steam for an engine of 257 h. p."

Bauerman goes on to show that each ton of coke yields 163,450 cubic feet of gases, so that the hourly yield of gas from the above small furnace will be 204,312 cubic feet. If this gas yields only 257 h. p., it follows that it must require 794 cubic feet of gas to yield 1 h. p. when produced through the agency of steam boilers and engines. It is well known that carbon monoxide gas, which burns with a blue, lambent, transparent flame is not efficient for steam raising, owing

to the fact that transparent flames have a very poor power of radiation. Mr. Galbraith, of the Wishaw Works, showed that 1 h. p. was obtained by the combustion of 94.2 cubic feet per hour in gas engines.

The following is the analysis of the gas as given by Bauerman and by Galbraith, together with the thermal equivalents for each:

	Bauerman.	Galbraith.
CO_2	9.21	7.21
CO	26.60	25.83
H	1.00	4.55
CH_4	....	3.45
N	63.19	58.96
	100.00	100.00
Thermal value per cubic foot at 60°	87.67	126.55 B. T. U.

Mr. Galbraith gave brake horse power. Let it be supposed that Bauerman intended brake horse power to be understood; then the comparison of steam and gas becomes:

Bauerman..... $794 \times 87.67 = 69610$ B. T. U.
Galbraith..... $94.2 \times 126.55 = 11901$ B. T. U.

From these figures it is seen that to generate a horse power by steam requires 5.8 times the thermal units required to develop a horse power by gas engines. It may not be out of place to remark here that the output of gas from a furnace appears to range, according to practice, from 160,000 to about 200,000 cubic feet per ton of coal. With the larger yields the gas is proportionately poorer; it contains more nitrogen, and the power produced demands a larger gas production per volume; but perhaps no very great difference of power is shown per ton of fuel. Assuming gas production to be an object, there can be no longer any reason for producing starved irons. Undoubtedly the economical tendency of the age forces managers to a course of action which tends, to say the least, towards starving the iron by depriving it of the desirable proportion of carbon contents, which it seems able to secure only under liberal treatment. The production of good iron seems to be possible only with a wasteful furnace. The natural corollary of iron manufacture is thus a rational utilisation of the waste gas, and electricity alone renders possible this desirable result.

A few further figures may be useful in respect of the analysis of producer gas and blast-furnace gas. Blount & Bloxam give the following analyses of ideal producer gas made from carbon only and of the ordinary gas of commerce:

TABLE I.

	Pure Producer Gas.	Actual Sample Producer Gas.	Blast Furnace Gas.
	Per Cent.	Per Cent.	
CO	34.4	22 8	26.66
N	65.6	63.5	54.91
CO_2	....	3.6	18.36
H	....	2.2	0.07
CH_4	....	7.4	....
O	....	0.5	....
	100.0	100.0	100.0

The use of coal accounts for the presence of the hydrogens, and, even with carbon only, the use of a little water gives a hydrogen content.

Average producer gas has a calorific value of 28 calories per cubic foot, or, say, 111 B. T. U. About one-third the total heat of fuel disappears in conversion to the monoxide, leaving only two thirds available. In the blast furnace the heat produced in the furnace goes to reducing the iron and forming slag and to heating the waste gases to about 500°. Hence the economy in using a counter-current system of cooling the waste gas and heating the blast air.

The same chemists give, for blast-furnace gas, the analysis expressed in column 3 of above table.

In table II are given other analyses from the furnaces at Wishaw and at Frodingham, where the gases are now being utilised. These may be compared with an analysis of generator gas given by Mr. Horace Allen.

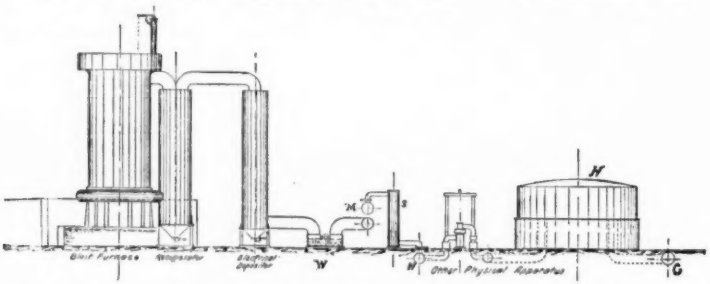
	Wishaw.	Frodingham.	Generator Gas.
Carbonic acid	5.75	6.00	6.60
" oxide	24.75	27.30	19.60
Hydrogen	2.33	1.50	6.40
Marsh Gas	0.75	....	1.30
Nitrogen	66.42	65.2	66.10
	100 00	100.00	100.00
Heat Units per Cubic Foot	97.8	96.7	98.0

The similarity throughout is very marked. Other analyses show richer blast-furnace analyses, but the two given are sufficient to show that the poorer productions of the blast furnace are almost identical with generator gas.

After a further trial of eighteen months since the writer's tests of

the Wishaw plant, he sees no reason to withdraw anything from what he then wrote. The words used were: "I am compelled to the conclusion that the system is theoretically sound, that it is easy of application, certain in operation, and of almost incalculable value as an adjunct to every blast furnace. The general adoption of the system would free the iron industry from the great reproach, now so justly levelled against it, of gross wastefulness of fuel. Indeed, there is no industry shows less result from a large fuel consumption. The system would have a comparatively poor and restricted field, but for electrical transmission; but with this aid every blast furnace may be set down as equivalent to a fall of water with dam and head canal ready made. The Thwaite blast-furnace-gas power plant is an unqualified success, and entirely practicable in both a mechanical and a commercial sense."

Plans are now in hand for the utilisation of blast-furnace gases at several English iron works, including one at Wigan, which is being prepared with a view to show the transmission of electrical energy to canal towage by means of small motors running on a light rail placed on the towing path. An entirely new plant is also in preparation at Poissy, France, where a blast furnace is being erected for the direct use of the iron for castings instead of for pig. The blast will not be



BLAST-FURNACE GAS PLANT AT POISSY, FRANCE.

hot, but simply moderately heated by means of a recuperator, the air blast being blown through a surface in a direction counter to that of the current. After passing the recuperator, the gases are passed through the electrical depositor, in which the dust is thrown down by the aggregating action of a magnetising charge of electricity. At W is a water seal, whence the gases pass to a longitudinal main, from which they flow through a series of scrubbers, S, placed in parallel between the mains, M, N. Other apparatus, such as transfer valves and filters, are interposed between the scrubbers and the holder, H,

from which the gas engines take their supply of gas by the main, G. This French installation is to be entirely new, from the blast furnace to the dynamos. It embodies the idea of blast only moderately heated, to obtain a good foundry quality of iron for direct casting. The blowing engines will be such as can be driven by gas engines, while the extent of the plant—5,000 i. h. p., to use all the gas produced by the furnace—will be such as to demonstrate on a complete scale the perfect practicability of the use of the waste gases. As compared with my own estimate of 10 h. p. per ton of fuel per week, an estimate by Mr. Horace Allen may be of interest. Mr. Allen assumes two furnaces, making each 800 tons of bessemer pig per week from hematite ore, Durham coke, and limestone. The coke per ton of iron is taken as 20.5 cwt. The following are the figures found by Mr. Allen:

Total pig iron per week, 1,600 tons.

" coke " " 1,640 " = 9.76 tons per hour.

Gas per ton of coke, 177,240 cubic feet = 1,729,862 feet per hour.

Thermal value of gas per cubic foot, 100 B. T. U.

Total hourly thermal value, 172,986,200 B. T. U.

Cubic feet per i. h. p. per hour 79.12 = 7912 units.

Total i. h. p. of gases = 21,863.

Weight of air blast, 46 tons per hour = 103,040 pounds.

Heat to raise blast to 1,210° F. = 33,488,000 units per hour.

Motive power to produce blast, 1,000 i. h. p., which, if produced by steam boilers, will absorb 542,000 cubic feet of gas per hour, or 54,200,000 heat units, leaving available 85,298,000 units for power purposes, or 10,780 i. h. p.

If, however, the blast were also produced by gas power, some 46,000,000 heat units would be set free for outside power purposes, which would increase the outside power to some 17,000 h. p.—a figure practically identical with my own.

Mr. Allen goes on to show that there is a continuous power available, even on his moderate figure of 6.73 h. p. per ton of iron produced, from which he deduces the motive power to be obtained from different furnaces as follows:

For furnaces making			300	tons	of	pig	per	week	2,019	i. h. p.
"	"	"	400	"	"	"	"	"	2,692	"
"	"	"	600	"	"	"	"	"	4,038	"
"	"	"	700	"	"	"	"	"	4,711	"

In whatever way the matter be approached, the possibility is so large that finely-drawn estimates are not needed to prove the enormous field for the utilisation of a hitherto wasted mine of wealth.

HEATING BUILDINGS BY THE WARM-AIR SYSTEM.

By J. J. Blackmore.

THE heating of buildings by warm air is usually understood to refer to the system in which the air is warmed by bringing it into contact with a furnace, and it is with this method of heating that I shall deal in this article. I mention this because buildings are heated sometimes by warm air that has been brought into contact with steam- or water-heated surfaces. Though in these cases the principle is the same, such systems are not usually classed as warm-air heating apparatus.

The principle involved in the construction of a warm-air apparatus is simple and easily understood, but the methods of applying it vary in different localities, depending largely on the comparative skill or education of the parties engaged in the business.

The operation of the system is governed by the forces of heat and gravitation, which are utilized for the necessary movement of the air. A fresh-air duct from the outside leading to the furnace, a furnace to warm the air, and a series of pipes leading to and connected with registers in the different rooms are the appliances necessary to make up an apparatus.

When the apparatus is in use, the outside air is colder than that in the house; hence it falls into the furnace by virtue of its greater specific gravity. The heat of the furnace expands the cold air, which, as it becomes warmer and lighter, starts up the pipes towards the rooms in which the registers are placed.

If the rooms to be heated have a fire-place in them, or some other means of exhausting the air from the room, a good circulation of the air will result; but, if the room is without such an outlet, the movement of the air will be slow, for the reason that a room full of air cannot well receive more till a corresponding quantity is removed.

The fresh-air duct or pipe leading to the furnace should never be less than 80 per cent. of the combined capacity of all the warm-air pipes leaving the furnace. If the quantity of air supplied is inadequate, only those rooms most favorably situated will get a supply, and very often, in such cases, air will be drawn down through some of the ground-floor registers to supply the deficiency, the rooms thus drawn from receiving little or no heat.

Figure 1 illustrates the application of a plant to an ordinary house. The pipes vary in length, according to the situation of the rooms relatively to the furnace. If the piping is not carefully planned, the

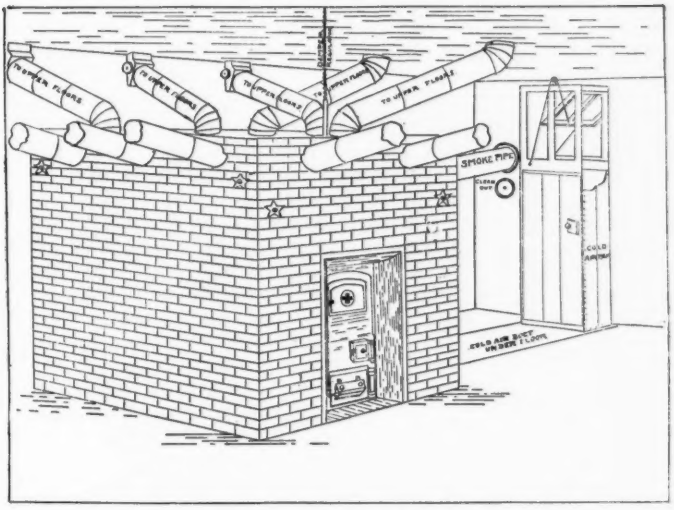


FIG. 1. HOUSE-HEATING FURNACE.

short pipes will take more heat than needed, and the long ones will suffer in proportion. To overcome this tendency, the longer pipes are made of larger diameter than the short ones.

The velocity of the air flowing through the pipes is much less on a first floor than on a second floor; hence pipes leading to the second or higher floors can be made much smaller, and the air will be able to overcome more friction than in the pipes leading to a first floor.

The velocity of flow through pipes to the first floor rarely exceeds three feet per second; but to the second floor the flow may be four feet per second, and to the third perhaps five feet. These velocities, however, cannot be depended on except under good conditions.

To heat an ordinary room it has been found necessary to supply sufficient warm air to equal three, and sometimes four, changes of its entire contents per hour. To heat a room $15 \times 20 \times 10$ on a ground floor a pipe fully 12 inches in diameter is needed, and the velocity of flow must be not less than three feet per second. The discharge of such a pipe in feet is $.7854 \times 3 \times 60 \times 60 = 8{,}424$ cubic feet per hour,—nearly three times the capacity of such a room.

This rate of change should be maintained steadily while the apparatus is running, and the heat of the furnace should be increased or diminished to suit the outside temperature.

If the horizontal warm-air pipes are long, these results cannot be

obtained with a 12-inch pipe, and the size has to be increased in proportion to the distance of the register from the furnace.

The second-floor pipes discharge from the register at the rate of about four feet per second, but a pipe one-half the size of those used for the first floor will usually supply all the heat needed for the second. The reason for this is that a large amount of heat passes from the lower to the upper floors by circulation independent of the furnace pipes. The upward pitch of the pipes as they leave the furnace materially affects the velocity of the flow; hence the furnace should be set as low in the cellar as possible. The pipes used for distributing the heated air are usually made of bright tin. It is wise to protect these pipes with asbestos and hair-felt covering to prevent loss of heat, especially in the case of long horizontal pipes.

The elbows or offsets needed should be curved to reduce loss by friction.

As each pipe leaves the furnace, it is usually provided with a cut-off damper to regulate the flow of air, as it is nearly always found that some rooms take heat more freely than others.

The registers used in warm-air apparatus are of three kinds. The flat oblong shape is mostly used for floors; the flat round pattern is used for both floors and walls; and the convex oblong pattern is used for inlets placed on the side walls.

The register should be at least 50 per cent. larger than the capacity of the pipe leading to it, for the reason that one-third of the capacity of the register is lost by the obstruction of the fret work of the register face. It is the custom to use a 10×14 register on a 10-inch pipe, a 12×16 on a 12-inch pipe, and so on; but even these sizes can often be increased to advantage.

Thermostatic regulators are now used by many firms to regulate the temperatures of the rooms by closing or opening the dampers of the furnace automatically as the temperature varies. These appliances give fair results, and assist materially in the management of the apparatus.

Some manufacturers advocate large fire pots, others deep fire pots; some use a comparatively small amount of heating surface over the fire pot, and claim that highly-heated surfaces do not have a detrimental effect on the air, while others claim that large surfaces over the fire pot give the best results. A careful comparison will show that the best and most expensive furnaces of all reputable makers have a heating surface definitely proportioned to the size of grate, and that the proportion of heating surface is larger than it is in cheaper grades of heaters. This indicates that large surface areas for the air to impinge upon have been found advantageous. All manufacturers are

not agreed on this point, however. It is a somewhat difficult task for the lay mind to determine which of the various kinds is the best. Without trying to settle the question, I will describe the conditions under which a furnace has to perform its work and how the heat it gives off may be utilized. The first task of the furnace is to burn the fuel properly,—*i. e.*, it must have a chamber where the various elements in the fuel and air may be united to produce combustion. This function of the furnace has a much greater importance than is usually ascribed to it, and, as a result, losses from imperfect combustion are frequent. In the burning of fuel rather more than two-thirds, under certain conditions, may be burned to carbonic oxide, an intermediate product of combustion; and, unless this gas can be further converted into carbonic acid, most of the heat which the fuel might have developed goes up the chimney with the smoke. Carbonic oxide is a combination of one part oxygen with one part carbon, usually written CO. The addition of one part of oxygen will complete the combustion, and develop all the heat which the fuel can yield. If the draught of a furnace is poor, or if the fire pot, or combustion chamber, is too small, enough oxygen will not be brought into contact with the fuel, or gases, to enable them to give off the heat that is in them; hence it is important that a good chimney flue should be provided, and that the furnace room should be properly supplied with air. The furnace should have a space above the fuel at least three times as large as the fire pot, to allow the gases room for combustion. The size of chimney required depends, of course, on the size of the house, but a furnace should not be connected to a flue less than 8 inches by 12, and houses containing more than twenty thousand feet of space should have larger flues.

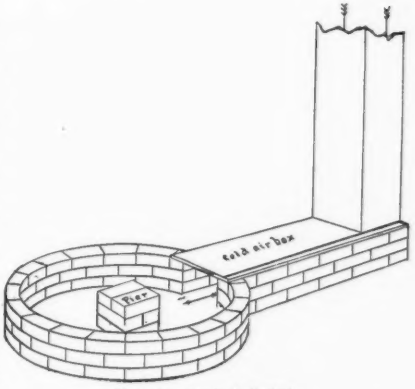


FIG. 2. COLD AIR BOX.

In a pound of the average grade of anthracite coal there are about 14,000 units of heat (one unit is the amount of heat necessary to raise one pound of water from 60° to 61° F.) In burning to carbonic oxide (CO) from 4,000 to 4,500 units only are given

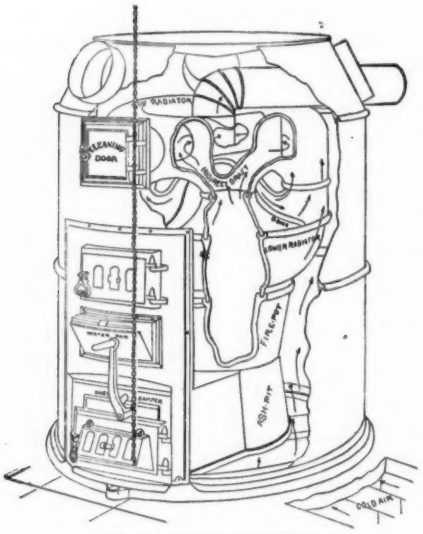


FIG. 3. PORTABLE SETTING.

off; the rest may all be lost through the fault of a poor draught or a badly-constructed furnace.

If a furnace is constructed with a large fire pot and only a small amount of heating surface above it, a large portion of the heat will be wasted (no matter how perfect the combustion may be), for the reason that the air coming into contact with the outer surfaces cannot carry off the heat as rapidly as it is generated, and the surplus escapes up the chimney.

We will now consider how the heat is taken up by the air as it comes into contact with the heated surfaces of the furnace. One thousand cubic feet of air at the temperature of zero weigh 86.4 pounds, and, as the specific heat of air is .238 and the temperature of the air delivered through the registers should be 140°, there would be absorbed by one thousand cubic feet 2,878.4 units of heat, as follows: $a \times b \times c \times d = x$, in which a represents 1,000 cubic feet of air at zero, b the weight of a cubic foot at zero, .08,641; c the specific heat of air, .238; d the number of degrees to which the air is heated, 140; and x the heat units absorbed by one thousand feet of air. To change three times an hour the air-content of a house having a capacity of 20,000 cubic feet absorbs in zero weather 172,704 units of heat, equal to 12.33 pounds of coal per hour, presuming no waste of heat. But, even in well-constructed furnaces, there is a loss of twenty-five per cent.; hence it would be necessary to burn 16.44 pounds of coal per hour to do this amount of work in zero weather. As a fire burns actively for sixteen hours, and at one-half its capacity for eight hours, in the twenty-four, we have twenty hours at the rate of 16.44 pounds per hour, or a consumption of 328.8 pounds per day, or, again, very nearly one ton of coal in six days.

Taking the average winter temperature in the northern portion of

the United States as 40°, it would be necessary to heat the air sixty degrees, requiring 6½ pounds of coal per hour, or, for 200 days, 13 tons of coal.

An apparatus heating and circulating 60,000 cubic feet of air per hour requires a cold-air box, or duct, 3½ to 4 square feet in area, and the air should be so conducted to the furnace as to make it impinge on all parts of the heating surface. The best way to do this is to take

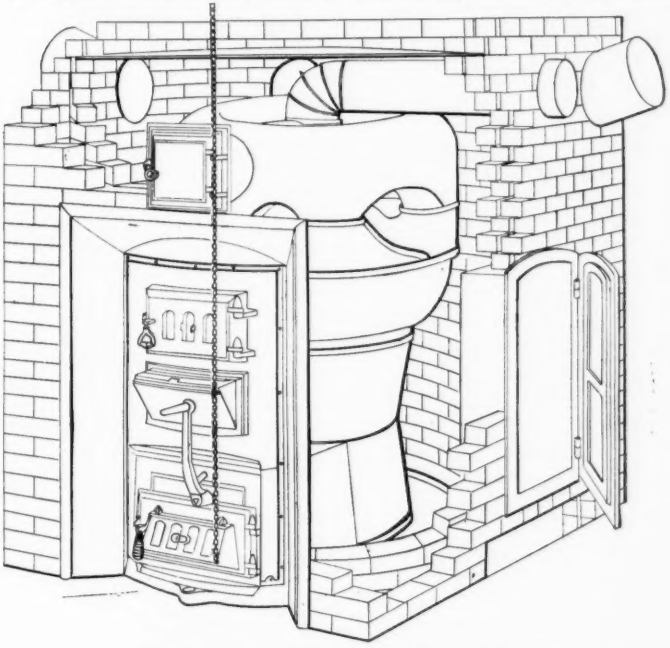


FIG. 4. HOT AIR FURNACE WITH BRICK SETTING.

it to the under side of the furnace, as shown in Figure 2. This enables the air to come up all round the furnace, and to readily take up its heat.

There are two methods of setting furnaces in general use. One, illustrated by Figure 3, is known as a portable setting. The furnace is set inside a galvanized iron casing, with sometimes an inner casing of tin or sheet iron, as an extra means of preventing loss through the casing, and to act as a radiator to take up the heat from the surfaces of the furnace, which is given again to the air as it passes through between the furnace and the casing. The other kind is known as brick

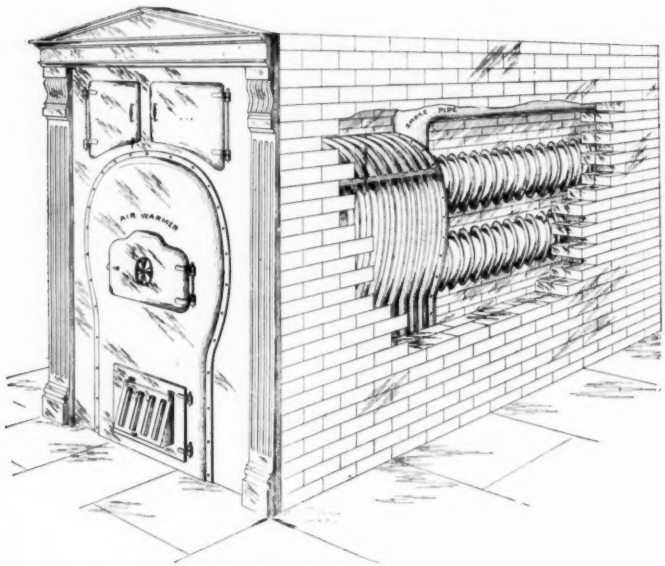


FIG. 5. OBLONG HOT AIR FURNACE.

set, and is illustrated in Figure 4. The method of taking the air in either furnace is practically the same, but the mode of taking the warm air from the brick work is different, as in the brick-set furnace some of the pipes may be taken off the top and others off the side, while in the portable form they are usually taken off the side of a conical-shaped member of the casing at the top of the furnace, as shown in Figure 3.

Furnaces may also be divided into two general classes, those of the round form, shown in Figures 3 and 4, and used mostly for residences, and those of the oblong form, shown in Figure 5, and used for churches, schools, and large buildings where large quantities of fresh air are needed for ventilation.

The heating of a suburban house is attended with more difficulties than that of a house in a city. Suburban houses are much more exposed and often not so well built. When the wind blows strong in any one direction, it become difficult to heat the exposed side, as the pressure prevents the warm air from going in the exposed direction. A city house, with narrow exposures only at front and rear, does not present the same difficulty.

To overcome this a number of manufacturers have adopted a form

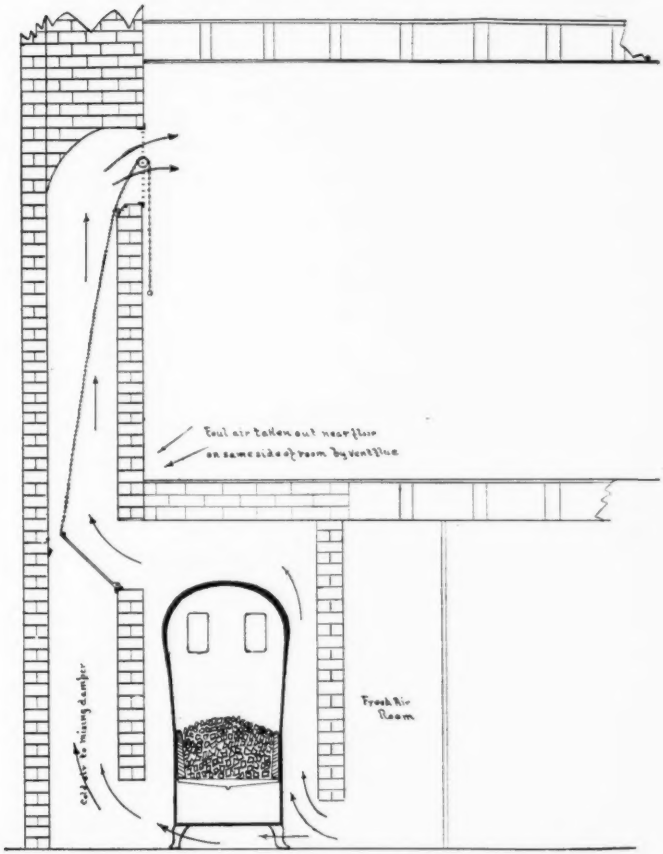


FIG. 6. GRAVITY SYSTEM OF HEATING.

of steam or hot-water generator, which they place in the combustion chamber of the furnace. From this generator pipes are taken to steam or water radiators placed in the exposed rooms, to aid in keeping them at the needed temperature. This adjunct to the hot-air furnace has not proved an entire success, though it has been the means, in many instances, of obtaining better results then could have been obtained by the use of warm air alone.

During the past ten years there has been a great development in the application of the warm-air system to schools, churches, and large

buildings, especially those requiring a large amount of fresh air for ventilation; and it is now common to warm and ventilate the rooms in such buildings to the extent of changing the air in the rooms from eight to twelve times per hour.

A great deal of this work is done by gravitation,—*i. e.*, moving the air by virtue of the heat transmitted to it, and exhausting the air by means of heated flues,—but the best work of this kind is done by the aid of fans. These fans are operated by electricity, gas engines, or water motors. Figure 7 illustrates the usual method of applying the gravity system of warm-air heating in schools. It will be noticed

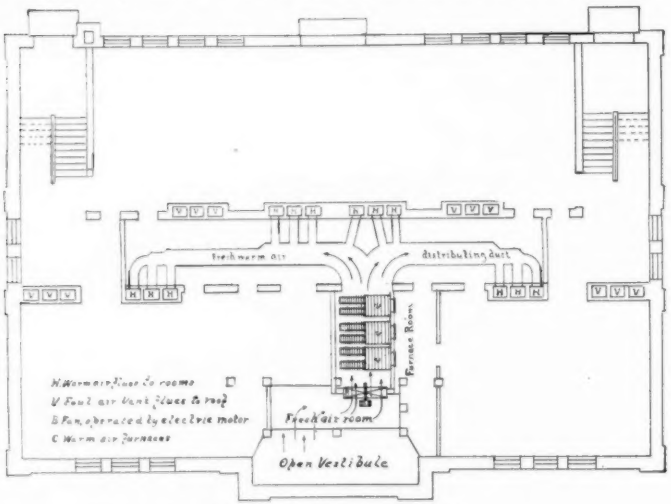


FIG. 7. WARM-AIR FAN SYSTEM.

that the damper in the warm-air flue is so arranged as to change the temperature of the air, but not to shut it off; hence the quantity of air flowing into the room is always the same. If the room gets too warm, the position of the damper is changed to allow more cold air to pass into the flue. These devices are called mixing dampers, and are controlled by the occupants of the room as the temperature varies.

Figure 7 shows a basement plan of a school building in which a warm-air fan system is installed. The furnaces are placed in one room, as close together as the conditions will admit; the fan receives the fresh air from the outside and blows it over and into contact with the heated surfaces, where it is warmed to the desired temperature before it passes into the galvanized-iron distributing ducts, which

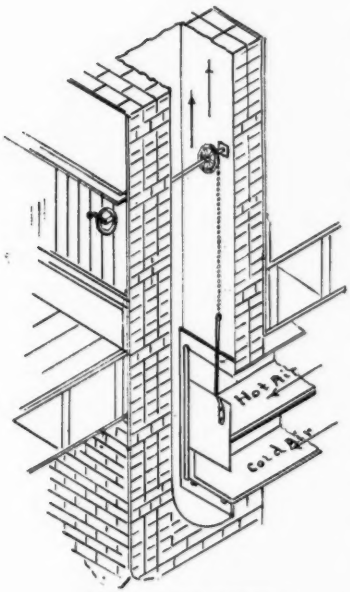


FIG. 8. MIXING DAMPER.

take the warm air to the base of the vertical flues leading to the various rooms. The distributing ducts are usually made double, the upper part containing the warm air and the lower the tempered air, or air that is warmed but little above the outside temperature. The cold air is blown into this duct by the same fan, but is delivered to the duct without coming into contact with the heated parts of the furnaces. The manner of connecting these ducts to the base of the flue, and the position and working of the mixing dampers, are shown in Figure 8. These dampers are frequently controlled by thermostatic regulators, which can be so arranged as to keep the rooms at a uniform temperature and deliver a fixed quantity of air at all times. If an apparatus of this description is put in by a competent firm, it will always give excellent results, and can be operated with great economy, considering the quantity of air heated. Figure 6 represents a type of furnace used for schoolhouses, and for all work where fans are used to propel the air.

The cost of placing a warm-air heating plant in an ordinary residence is from 1 to 1½ cents per cubic foot of space heated, the price depending on the exposure of the house and on the character of the various fittings used in the plant. For schools, the gravity system costs on an average two hundred dollars per room, counting the main hall as one room, but not counting the teachers' room, and other small rooms as anything. The fan system illustrated in Figure 7 costs about $250 per room.

UNPROFITABLE ENGINEERING PROJECTS IN WESTERN AMERICA.

By A. G. Allan.

WHILE there are to be found all over the western States a number of different channels in which capital can be profitably invested, there has been foisted on an unsuspecting public in the past ten years a large number of absolutely worthless projects. Millions of outside money have been sunk on the wildest of wild-cat schemes, projected usually by a class of "promoters" peculiar to the west, and always without the slightest regard to business needs or local conditions, ending with the inevitable—bankruptcy. In writing of these schemes, in which so much money has been lost, the writer desires most earnestly to impress on the readers of THE ENGINEERING MAGAZINE that there is plenty of good scattered among the bad (if not, it would have been impossible to have got rid of the worthless), and that it is the local conditions peculiar to the western United States that make these schemes so easily workable.

Outside of the railroad question, which we will not consider here, the largest development work in western America has been along the line of irrigation. We all have heard of the great engineering feats accomplished, the large sums of money spent, the enormous amount of desert land made valuable, etc. The question naturally arises: "Do these large canals pay?" The answer must be: "They do not."

In the richest and oldest irrigated farming community of Colorado only one canal in five has ever paid its expenses, only one in eight has yielded any profit, and two out of five of the largest canals have resulted in absolute loss. This is not an encouraging showing. Some of the various causes the writer will now point out.

In one case a number of farmers who had been dried out several years in succession organized an irrigating company for the purpose of voting bonds to build a canal. If any canal should have paid, this should. There was plenty of water, easily obtainable; the canal was very short, with a small cross-section in a light soil; and the farming land to be irrigated, though it looked as level as a floor, had sufficient fall to allow thorough flooding. Alas! the project was a terrible failure. The bonds were voted, and finally sold to representatives of eastern capital for nearly face-value, with interest at the rate of eight

A DRY CANAL, TAKEN FROM A DRY CREEK, DUG TO SELL DRY LAND.

per cent. per annum. A grading machine was bought, and everything made ready for the work, when it suddenly occurred to one of the projectors that a survey would be next in order. The manager (as is unfortunately the case in nearly all these coöperative projects) was a genuine freak, and decided that, as he could not get a civil engineer for less than five dollars a day, he would do the surveying himself. So he equipped himself with a level on a tripod furnished with peep-sights. Teams and scrapers were put to work behind this

DRY CANAL, DUG TO SELL SPECULATORS' LAND; AND IT DID.

CANAL 40 FEET WIDE, BUT DRY.
$10,000 invested capital lost by over confidence.

surveyor, and fourteen miles of the canal were completed before the headgates or road bridges were built. When the water was turned in, it refused to travel down the excavation, and a small panic ensued, the writer being hurried to the scene by the moneyed interest only to be compelled to condemn the entire work. So now the wind blows the sand up and down the bottom of that canal, while the eastern capitalists have a very unprofitable western investment.

Railroads do not pay, if they cost too much, or if there is a big swindle in their construction, or if built where no traffic can be developed. So it is with the large irrigating canals, some of which cost too much honestly-spent money. In a locality where land with a fair water right sells for $15 an acre, it will not pay to put water on more land at $25 an acre. Almost all the large canals cost twice as much as the preliminary estimate. Not that the engineer was incompetent or dishonest. He was probably employed by an unscrupulous "promoter," in collusion with a dishonest banker. If the actual cost of the canal was $10 per acre, the "promoter" either insisted on an estimate of $5 per acre, or changed the estimate to that figure.

"With this the banker could make an enticing appeal to the investor. He would figure out one hundred per cent. profit on the water-rights, and often another enormous profit on water rents and assessments of, say, $1 or $2 per acre for maintenance. In such cases the 'promoter' and the banker 'got from under' with a big 'rake-off' before the inevitable crash came."*

* *Irrigation Review.*

What the average eastern man cannot understand is the division of water in an irrigating district, and the reason why some of the largest, longest, and therefore most expensive canals are sometimes the driest. In the settlement of a new country the earliest settlers take up the river-bottom lands, which are easily watered by short, small ditches; the next settlers take up lands lying farther back from the rivers; while the table lands out of the river valleys are settled last. To water these latter lands naturally requires long and expensive canals. Now, the irrigated areas are divided into districts, each having a drainage basin, or portion of one.

Each district has a water commissioner, appointed (in Colorado) by the governor of the State, whose sole duty it is to divide the available water-supply, *pro rata*, among the different ditches. As the older ditches have prior rights, the later canals, which cost far more to construct (per acre watered) and cover larger quantities of land, are the first to be cut off by the water commissioner when the supply in the river gets short. Nearly all of the money lost by eastern investors in irrigating enterprises has been sunk in these high line canals.

The day of profitable investment in large irrigating works has gone by, never to return, as far more land is now under ditches than can possibly be watered with the natural supply, while the later canals do not get enough water to enable the farmers to raise a crop.

In a new country, where towns and cities are building up rapidly, there is a chance for profitable investment in building lots. This fact

A GENUINE IRRIGATING CANAL.

is taken advantage of by a certain class of "boomers," who "give away" every alternate lot in order to "enhance the value of the property," or sell lots for $1 each "to get people interested."

Several years ago the writer, being instructed to make an examination and report, in the interest of some eastern gentlemen, on an investment of this class, journeyed to a small town in the eastern Colorado "rain-belt." This is a region in which crops are supposed to grow without any irrigation, but, since the rainfall every third year, speaking roughly, is so small that only the poorest kind of a crop can

"A GARDEN TRACT GIVEN AWAY."

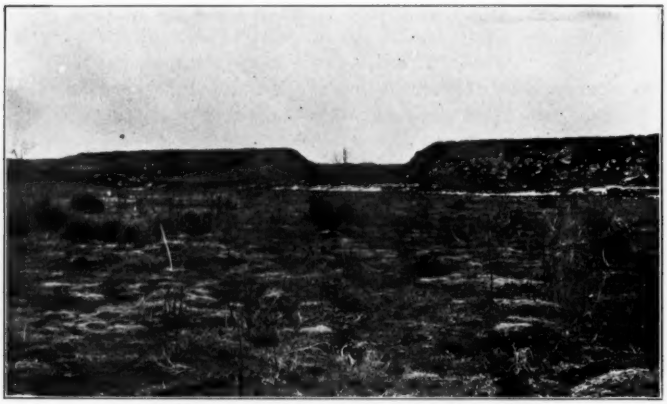
be raised, the cash value of a quarter section of land (160 acres) is from $250 to $300.

Arriving in the town, which contained a few houses and perhaps 150 inhabitants, the writer spent some time in finding the headquarters of the "improvement company," as in such a place one has to be diplomatic enough to obtain the information required without asking too many questions. The office of this widely-advertised concern was not more than 8 by 10 feet in size, the furniture consisting of two chairs and a table, and the nearest "addition" to the town was several miles away. The "company" really gave deeds to a 25-foot lot (?) of desert, charging $4.95 per lot for making and recording the deed. As the county clerk recorded at special rates "by the thousand," so that the total expense, including the purchase price of the land, did not exceed 70 cents per lot, and as the "company gave away" several hundred lots per day, the business was very lucrative.

LAND TO TRADE FOR HORSES, PIANOS, OR ANYTHING.

Another instance of this nature, exploded a short time ago, shows the manner in which these schemes are handled. A short distance from one of the richest farming and market gardening spots to be found anywhere in the west there is some very rough and rocky land. This land was originally "homesteaded" by a sawmill owner for the purpose of utilizing the scrub pine trees growing upon it. Most of the logs were got to the mill by sliding them down the steep side-hills. Having obtained everything of any value from the land, the

A GENUINE COLORADO POTATO FARM.—260 BUSHELS TO THE ACRE.



A DRY RESERVOIR, PHOTOGRAPHED FROM THE INTERIOR.
The view is toward the place where the spillway used to be.

owner left for parts unknown, turning over his real estate in payment of a small grocery bill. After numerous transfers the land was platted, placed on record by a real-estate broker as a "garden addition," and, on the reputation of the real gardening section adjacent, sold as garden (?) tracts, in some instances being exchanged for horses, pianos, hardware, etc. It is surprising how many people own property in that garden addition.

These land schemes are most easily carried through in a thickly-

A GENUINE RESERVOIR, WITH WATER ENOUGH FOR 600 ACRES.

settled country where real estate is worth something, as it seems impossible that the value of realty there should be less than the annual tax upon it.

Another very profitable line for the "promoter," for many years, was the factory plan. As a simple money-making scheme this was remarkably successful. The *modus operandi* was to first visit some busy town of, say, 6,000 inhabitants, and work up a mass meeting, at which some silver-tongued orator would explain the advantages of factories in raising the value of real estate, increasing population, etc. A committee would then be appointed to secure subscriptions to a bonus

"FARM" BOUGHT BY AN EASTERN INVESTOR, WITHOUT PRIOR EXAMINATION.

or subsidy for the purpose of attracting manufacturers. The "promoter" would then leave for the east, and, on the strength of the cash bonus, float a stock company and issue stock and bonds, often exchanging the corporation paper for useless old machinery, fit more for the scrap heap of an iron foundry than for a new (?) factory. A balloon-frame, or perhaps cheap brick, building would be erected, and the machinery placed in it, and then the skilful "promoter" would draw his cash bonus "for working capital" and move on to fresh fields to conquer. The writer has in mind woolen mills, paper mills, a plow factory, a cracker factory, and an oatmeal mill, built for the different stockholders and respective communities on the above plan.

Of all things that a capitalist ignorant of mining and mines should avoid is investment in a mine on his own examination; yet mines and mining stocks are bought and sold by people utterly without information concerning them, or the companies interested in them.

Professor Lakes, in his "Prospecting for Gold and Silver," says:

"AN OUTSIDE ADDITION TO TOWN," 18 MILES FROM A POST OFFICE.

"On entering a mining camp in the far west, especially in the more remote outlandish districts, an investor or an expert may consider that the whole village, from the hotel bellboy to the mayor (who, by the way, may be the principal saloon-keeper), is in league against him. Directly he arrives, everybody in town wants to know his business; on this he should keep as mum as possible, and, if he can,

A DESERTED MOUNTAIN TOWN, FOUNDED ON THE HOPES OF WORTHLESS MINES.

throw pertinent inquirers off the scent. The idea is: 'Here is a capitalist to fleece, and an expert to delude.' Every one, too, has a hole in the ground of his own to present. . . . And, if you mention any property, you will invariably hear it cracked up. The Eastern 'tenderfoot' is somewhat of a 'sheep among wolves' in such a camp. . . . What man ignorant of horseflesh would venture to buy a steed from a professional horse jockey, without taking with him a friend who is knowing about horses? How much more so, in

A GENUINE COLORADO TRUCK GARDEN.
135 sacks onions to the acre—sacks 100 lbs. each.

such a difficult and delicate problem as that of purchasing a mine, is it the duty of an investor never to purchase, or induce his friends to purchase, a mine, until he has employed the services of a competent expert to previously examine it. If the expert's fee should amount to a few hundred, and, after all, he should decide on condemning the property, it is far better for the company to entail this expense, and perhaps lose this small sum, than to involve themselves in the loss of thousands of their own as well as other people's money in a bogus, worthless, or wild-cat scheme."

It is, of course, impossible to give a complete diagnosis of the worthless western company, but a few general hints may be useful. If the following counsel were more widely known and heeded, it would be impossible for any one to float any more of these swindling corporations.

Beware of any unknown land, improvement, or canal company,

issuing stock or bonds in small denominations over a wide area. This is a significant sign, for the small investor never does much investigating, and, the more scattered the distribution of such securities, the more successful is the "promoter."

Never buy small farm mortgages without actually seeing the land, making sure that the land mortgaged is the land viewed. It is not uncommon to find a valuable homestead, with good buildings, and highly-improved land adjacent, divided only by a land line, or fence, from the most worthless sage-brush desert. The farm mortgage a few years ago was one of the quickest methods of permanently investing capital in real estate which would neither pay dividends or increase in value. This, however, was not, and is not, true of the genuinely-irrigated farms, which are good securities for reasonable loans.

While nearly all of the large canals built by outside capital in the western States have come to grief, the smallest and oldest farm ditches are the most profitable property imaginable. Farms relying on the larger canals are, in general, somewhat doubtful as collateral or for purposes of investment, but lands under the small ditches with the earliest appropriations are assured of a crop every year.

Building-lots, in any town, ought to be seen before buying. To invest from a plat is to court disaster. In an experience of fourteen years the writer has examined lots laid out in the bed of a wide river, in dense swamps, as well as on sage-brush and cactus desert, miles from anywhere, which must have been bought by investors from finely-engraved maps showing other features than those actually on the ground. Lots in any western town may be of some intrinsic value, but, if in outside additions, ought to be looked on (until examination) as very doubtful.

The reckless promotion of land, irrigation, town-site, factory, or mining schemes has not been confined to any one State, but seems to have been general throughout the west, the worthless being thoroughly interspersed with the valuable and often difficult to distinguish. No one would buy a grocery store without examination; then, why throw ordinary prudence to the wind, and buy stock, bonds, or interests in an unknown mine, factory, or other corporation, thus paving the way for a total loss of capital, giving the unscrupulous "promoter" a chance to assert himself, and doing not only an injustice to genuine projects, but an incalculable injury to the entire west?

THE GROUND CURRENT OF ELECTRIC RAILWAYS.

A DISCUSSION OF THE CAUSES AND EFFECTS OF ELECTROLYSIS.

By Albert B. Herrick.

IN discussing the action and influence of ground currents in an electric railway, the usual methods of conveying currents should be fully understood.

Following the usual custom of supplying trolley cars with a current of electricity required for their operation, the trolley wire is fed from the positive pole of the generator; the current passes through the motors, performing its work of propelling the car, and then is delivered to the rails. So far in the circuit the current is confined to a definite path. On reaching the rail it may either follow the rail back to the power station, or ramify through the earth; it always follows the path of least resistance. Sometimes it travels by sub-surface conductors belonging to the gas and water companies, but, in passing from one metallic body to another when imbedded in earth, especially that found under city pavements, which is charged with nitrates and ammonia, the current carries with it a certain portion of the conductor on leaving it to enter the earth. It is this action which causes electrolysis of the rails when the current leaves the railroad, and of the water pipes or other conductors when it leaves these to return to the power station. It is evident that, if the current, in passing along the rail, reaches an open joint, it will pass into the earth and back into the rail, bridging this joint. The same action will occur if a joint in an iron water pipe or a gas main offers resistance to the current. The effect of electrolysis can be reduced to a minimum, or to a negligible amount, by taking certain precautions and maintaining a periodical inspection and tests of the return flow.

The rail itself generally offers abundant conductivity, except on very large roads. But, as the rail is not continuous, the conductor is broken up into lengths, which are connected by splice bars. Oxide of iron being a partial insulator, these splice plates do not make a good electrical connection between adjacent rail ends. In order to make the rail a continuous conductor, some way must be found to bridge around and connect the rail ends electrically. The bonding of these rails has been a matter of considerable study, and the evolu-

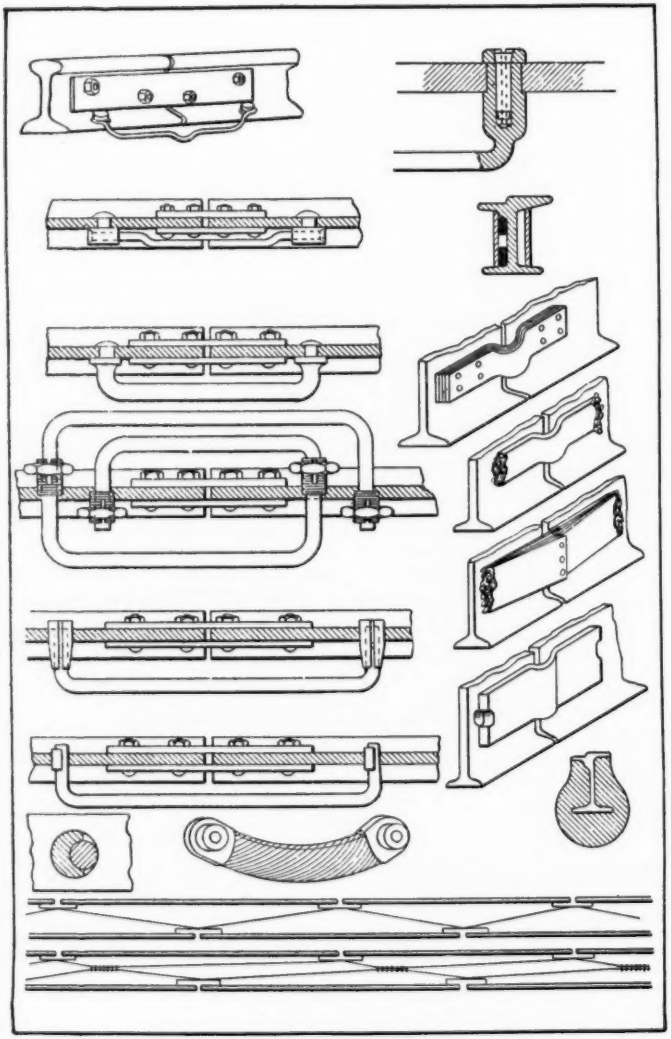


FIG. I. THE EVOLUTION OF THE RAIL BOND.

Showing the development from the signal-wire connection through the various forms of copper rod bonds, brazed plate bonds, cast-weld joints, etc., to the continuous wire conductor connected to every joint.

tion of the rail bond is given on page 452, where the different forms that have been used are shown. First is shown the simple method adapted from the railroad-signalling systems,—an iron wire secured under the head of a rivet. The next step was to use several of these in place of one, introducing them around the fish plate. The next was to substitute copper wire for these galvanized iron bonds; the matter of making contact between the copper wire and the rails has been the subject of a number of patents, and bonds of various types are now on the market. The channel pin has been used extensively. A hole is drilled through the rail, the copper wire is threaded through the hole, and enough room is left between the hole and copper wire for the introduction of the taper key to connect the rail and the wire. Copper rod, with a rivet head on both ends, is also used for bonds. In another form the copper entering the web of the rail is enlarged, and in it a hole is drilled, into which is forced a taper pin. In another method a split collar is secured in the flange of the rail and thus forced into contact with the copper rod bridging the splice plates. A steel cap split and tapered, has also been used into which is thrust a copper rod, the taper cap being forced into the flange of the rail to secure connection. Another device uses a split ring tapered and forced into the flange of the rail; this ring, surrounding a copper conductor, secures a contact between the rail and the conductor. Such are the principal forms of what is known as the external bond. These bonds are exposed to electrolysis themselves, for the reason that the considerable current traversing them tends at these points of concentration to leave the bond for the earth.

The next step was to introduce a bond between the web of the rail and the inside surface of the tie bar. Bonds in this position can be made much shorter and of larger sectional area, and consequently they form a better electrical conductor between the adjacent ends of the rails. Flexible strips of metal have been brazed to these adjacent rail ends, and bolted together with the rails. Also, a bridge piece of copper has been brazed to both rails. A flat copper conductor with rivets passing through the rail has been used to connect these adjacent ends.

In order to make a continuous conductor between two rail ends without contact surface, an amalgam has been used, making a flexible solder between the conductor forming the bond and the web of the rail. Amalgams have also been used between the web of the rail and the fish plate, allowing the current to be carried into and out of the fish plate in order to bridge the rail end. Beyond this development of an auxiliary method of connecting the rails electrically, the butt ends of the rails have been actually welded together, or iron has been

cast around the rail itself The latter method has a greater advantage mechanically than electrically.

As the product of electrolysis is in itself an insulator where iron is concerned, the currents traversing the water or gas pipes continually vary, both in quantity and direction, as the continuous action increases the resistance of both, tending to divert the current to other paths. The temperature and moisture of the earth affect these currents.

There is no panacea for the evils arising from electrolysis, but there are general treatments which greatly relieve the condition. The damage is done when the current leaves the water pipe. If these points of departure are determined, by measuring the difference of potential between the rails and the affected system of underground conductors, and if the volume of current flowing through the parallel conductors adjacent to the railway system is known, certain areas where the current leaves the water or gas pipe and returns to the rail or to the ground will be indicated. It is generally assumed, but not correctly, that the difference of potential between the water-pipe system and the railroad indicates the true extent of electrolysis. It does indicate a tendency to divert the current, if the rail is negative to the pipe, but the amount of current diverted can be determined only by electrical measurements on the water pipe itself. The distribution of negative and positive areas must also be considered. The negative areas are adjacent to the power station, whereas the positive areas are the outlying districts. This is the case where the trolley is positive, which is the usual practice. It is evident that, if conductors were attached to the water pipes at the points where they are positive to the rail and carried back to the negative poles of the generators, the current would follow this path in preference to returning through the earth to the rail. This will reduce local electrolysis, but will tend to increase the flow of current through the water pipe, and, if there are any bad joints in the water pipe, the pipe will be badly eaten at these points. Cast-iron fittings and cast-iron pipe are not attacked or destroyed nearly so rapidly as wrought-iron pipe. Lead surfaces and brass nipples connecting lead surfaces with wrought-iron pipe suffer quickly from electrolysis. Gas pipes carrying an insulating medium are not so subject to marked depreciation from electrolysis, unless the ground return of the railway is in very bad shape. There is a condition of water distribution which has to be carefully guarded against. In the old systems of water piping cement-lined sheet-iron pipe was used. Now wrought-iron pipe has been so cheapened that these systems have of late been extended with wrought-iron pipe. With this mixed system of piping the matter of electro-

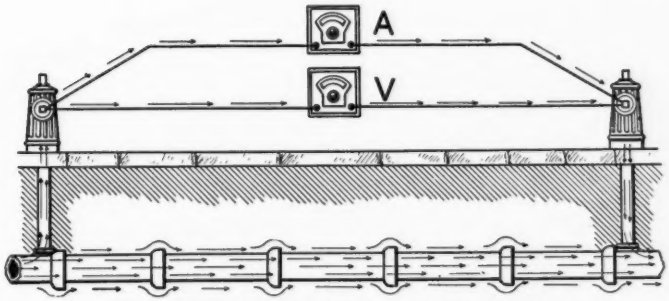


FIG. 2. TESTING QUANTITY OF CURRENT IN WATER PIPES.

lysis may become very serious, as the current enters the wrought-iron pipe on its way to the station, only to be diverted as soon as it meets the high resistance offered by the cement-lined pipe, whereupon it disseminates through all metallic surfaces, such as gates and surface pipes.

It often becomes necessary to determine what should be done by the railway company to protect the property of the gas and water companies from the deterioration due to electrolysis. It is not necessary, as a rule, to impose any great burden on the railway company in order to accomplish this, if the system is gone over carefully and an examination made to determine the causes and localize those points where the action is dangerous.

The methods of determining these localities are very simple, but tedious; the following tests, if properly plotted out, will indicate the points which must be determined before the remedy can be indicated. Starting from the power station, and connecting the rail and the exposed water plug by a voltmeter reading to about ten volts maximum, to be sure that good electrical connection is made on both, a differerence of potential will be shown between these two points ranging from one-tenth of a volt to twenty-five volts. It is well to observe this as a car approaches and recedes from the point of test. If the polarity changes; if the pipe is positive to the rail as the car approaches, and negative to the rail as the car recedes,—the car is delivering a large part of its current to the water-pipe system. If two adjacent plugs show a remarkable difference of potential, it is sometimes due to a bad joint in the water-pipe system, between the plugs. The method of testing the current flowing in a pipe is applied as follows: if the tension between two adjacent plugs by means of a long pressure wire can be determined, and if these two plugs then short circuit by means of a cable of low conductivity through an

ammeter, Fig. 2, the current flowing in this short-circuiting cable and the potential being known, it is easy to determine what the flow of current is in the pipe when the shunt of known resistance has been placed around the pipe, for the current will flow proportionately to the resistance of the two paths of the water pipe and the shunting cable.

The remedies applied are: first, to connect the rail to the water pipe at points where the pipe is positive to the rail; second, to use feeders, preferably by connecting the pipe at this point directly back to the station. Another method is to take the current from the water mains through a dynamo whose potential is negatively lower than the rail-return dynamos. Or the return through the ground and water

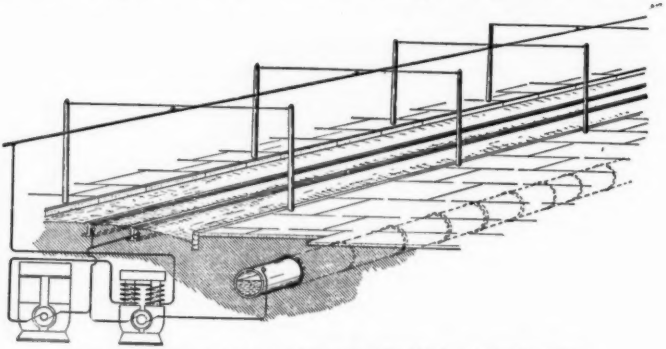


FIG. 3. METHOD OF CORRECTING ELECTROLYSIS IN WATER PIPES.

pipes may be fed through the armature of a low potential machine, keeping this system electrically negative to the rail, so that the current does not leave the water-pipe system, but naturally returns through this generator as the lowest potential point in the system, Fig. 3. The excellency of the bonding of the track and the proper placing of ground-return feeders is the most practicable and direct method of reducing electrolysis. If care and attention are given to these details, electrolysis can be reduced in most instances to a negligible quantity; this can be assured also by a few subsidiary feeders connected to the water-pipe system.

Another interesting point is the question of the responsibility of railroad companies for depreciation of the water-pipe plant. As no one has a right to the earth or to earth return, the responsibility of the railroad company has yet to be defined. Electrolysis is characteristic in its action. It will pit and seam piping in a way that rust does not, and in lead pipe solvents are always present in large quan-

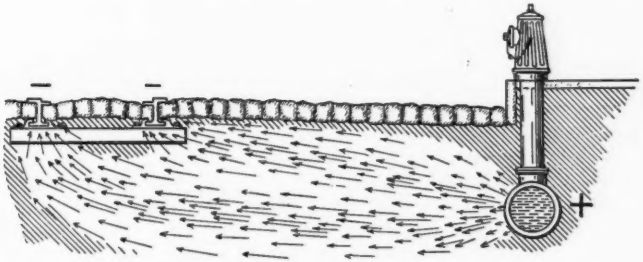


FIG. 4. A GRAPHIC EXAMPLE OF ELECTROLYSIS.

tities around or adhering to the pipe. Electrolysis in brass always eats it to needle points or knife edges. The soil through which the railroad and the pipes run has a great deal to do with the division of current between the two parallel circuits of water pipe and rails. Clay, as a rule, is the best insulator. Loam charged with salt water offers the lowest resistance. If loam or clay be charged with coal gas or sewer gas, the resistance is greatly reduced. Dry sand ranks next to clay as an insulator, and wet sand next to loam. Soil having water underlying it is always a low conductor; the current leaving the rail increases the capillary activity of the soil and draws water towards the rail. The rail positive to the soil is always moist.

THE IMPROVEMENT OF THE MISSISSIPPI RIVER BY DREDGING.

By H. St. L. Coppée.

THE practicability of improving the channel of the Mississippi river by dredging, and the relation of such improvement to the more permanent methods heretofore adopted, constitute a question not only worthy of discussion by engineers, but of interest to economists everywhere on account of the functions of the river as a great commercial highway and its important influence in problems of transportation affecting the world's supply of food and manufactured products.

After many years of study, experiment, and active construction, and the expenditure of millions of the public funds, the problem of the improvement of the Mississippi river is still in its infancy. More intimate acquaintance with the laws of its flow and power requires new departures in the general plan for the amelioration of its navigation. Dredging on a large scale, at first considered unnecessary, is one of these departures.

Heretofore the general plan of improvement has been practically the same from St. Louis to the mouth of the river, consisting in three distinct lines of procedure.

First, the contraction of the low-water flow to a normal width by means of lateral dykes and spurs, closing chutes, and auxiliary channels.

Second, the protection of the banks from abrasion and undermining by means of mattresses, submerged spurs, and other forms of revetment.

Third, the regulation of the high-water flow, thus keeping the thalweg as nearly as possible in the same relative position at all stages, by means of levees.

From St. Louis to Cairo, 180 miles, the work has been performed under the direction of engineer officers of the army, and paid for mainly out of funds appropriated specifically for that particular reach of river.

Since 1879 the improvement of the river from Cairo to New Orleans has been under the direction of a commission of seven members, men of national reputation and unquestionable engineering ability.

On the river below Cairo the work of permanent channel improvement, not including levee building, has been confined practically to two reaches, the principal harbors,—Hickman, Columbus, New

Madrid, Memphis, Helena, Greenville, Vicksburg, Natchez, and New Orleans,—and for the prevention of cut-offs, outlets, etc. Much of this work was necessarily experimental, and, though successful as a whole, has proven vastly more expensive than it was expected to be.

It has been demonstrated that this mighty river can be controlled and eventually trained between permanent banks without either raising its bed or destroying the great agricultural domain adjacent thereto, but this result can be obtained only by the expenditure of a large sum of money, far more than was at first deemed necessary,—a sum almost beyond the the limit of obtainable public funds under the form of government and present status of public opinion in the United States.

It is now conceded by many engineers familiar with the problem that, in order to obtain the best results, the permanent work should commence at the head of the alluvial river and be extended down stream from year to year until the entire channel has been regulated, local works, which would ultimately form a part of the continuous system, being carried on for special purposes from time to time.

By a system of bank revetment or other protection commencing at the head of the alluvial basin is not meant a continuous revetment irrespective of general physical or topographical features; these, of course, will be potent factors in the problem, and will have to conform to certain limits, the river being allowed to cave at certain points until given degrees of curvature, slope, etc., obtain, and the effort being to obtain as great a length of river and as light a slope as possible, so that, when the bar building ceases, the conditions of depth and flow will conform more nearly to those existing below the mouth of the Red, where navigation is safe and permanent.

In order, therefore, to improve the river as a whole from Cairo to New Orleans, some caving bends would be passed by (though the general plan would be to protect each), and many isolated reaches would be revetted, irrespective of the continuous work.

In the present river, from Cairo to the mouth of the Red, there are about* 406 miles of caving bends. By making an allowance for additional caving produced by the new work, and eliminating the banks where protection may be unnecessary, the distance will not be materially changed. The cost, at the present rate for the most effective means of protection,—$160,000 per mile,—would be, roughly estimated, $67,000,000. Adding 10 per cent. for repairs and plant, the total cost of permanent bank protection becomes $73,700,000.

With an appropriation of $3,700,000 per year for twenty years,

* See report of Mississippi River Commission for 1896, page 3458.

this work might be accomplished, but it would necessitate the construction of about twenty miles of revetment each year, and involve great additional expense in procuring materials, such as brush and poles, that would have to be cultivated, or obtained at a great distance. In addition to the permanent work, the proposed dredging would cost in twenty years, in accordance with Colonel Henry Fladd's estimate for a channel 250 feet wide and 9 feet deep at low water from Cairo to Natchez, as follows:

For plant	$1,188,000
Dredging	6,996,000
Total	$8,184,000

Adding, as the amount necessary to perfect the levee system, $20,000,000, we have the following approximate total for completing the improvement of the river from Cairo to the jetties:

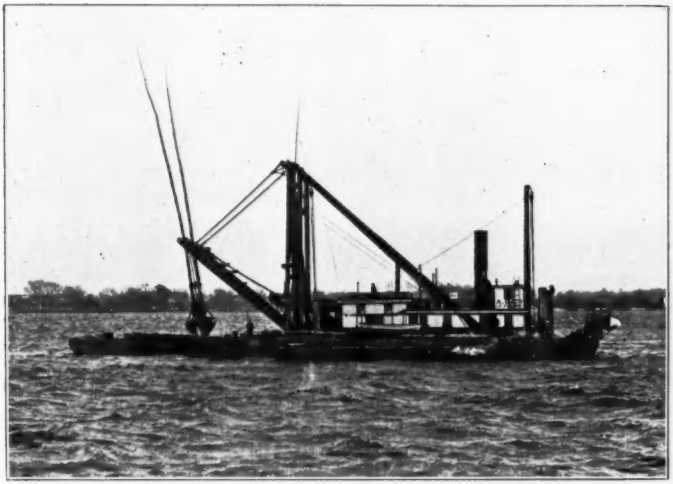
Permanent channel improvement	$73,700,000
Levees	20,000,000
Dredging	8,184,000
Total	$101,884,000

The fact will be appreciated at once that the obtaining of this vast sum in twenty years is, to say the least, doubtful.

In order to maintain a safe and paying navigation at all seasons, the plan of dredging the bars or shoals each low-water season and controlling the floods as far as possible with the funds allotted for that purpose has been adopted. The revetment to prevent cut-offs and outlets, and the maintenance of existing structures, are also parts of the general project, but continuous channel improvement, owing to the great cost, has been abandoned, at least temporarily, by the commission. Experiments are being made on a detached revetment or dike project designed by Colonel Amos Stickney, which, if successful, will revolutionize bank protection on the Mississippi river and bring the cost of permanent improvement well within the limit of obtainable public funds. It is only after many years of experience that it has been demonstrated that structures which control the flow in other streams are ineffective, or nearly so, in the Mississippi.

The methods adopted for permanent improvement, both high and low water—revetment dikes and levees—have been fully explained, in the past few years, in many reports and papers.*

*See Coppée on revetment. *Proceedings American Society of C. E.* and ENGINEERING MAGAZINE, June, 1896. Also Starling on Holland dikes.



A CLAM-SHELL DREDGE IN OPERATION.

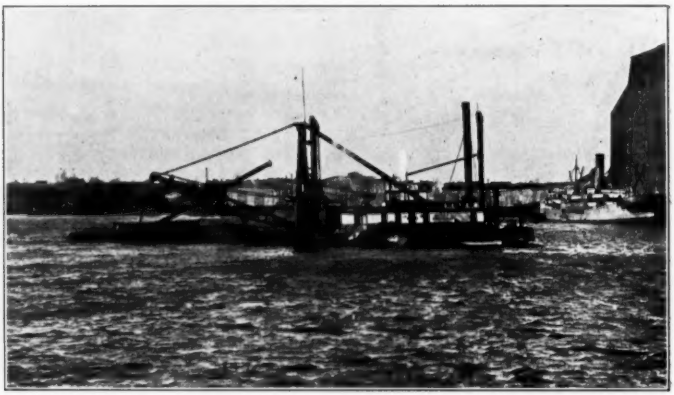
The bars obstructing navigation and necessitating the use of dredges are formed at high water; at low water the river is, to a certain degree, a series of pools and shoals. As the water falls below a half-stage plane, the shoal or bar is cut by one, or, oftener, more than one, channel, dividing the discharge of about 300,000 cubic feet per second at medium low water over a large cross-section and perhaps into numerous small chutes. The bars (also termed crossings), as they usually exist where the thalweg crosses from one side to the other, are generally composed of compact sand, sometimes mixed with gravel, and are about one hundred in number between St. Louis and Vicksburg. Some years the river does not reach a very low stage, and a depth of 8 feet or more is found on all the crossings. At very low stages the depth is reduced, in places, to 4 and even 3 feet. Nine feet is the greatest low-water depth which it is expected to maintain at first by the dredging operations.

Before excavating the bar, the purpose is to ascertain the locus and direction of the natural and deepest pass, and so deepen the bed in that direction as to concentrate the greatest flow into and through one well-defined steamboat channel. The first requisite is a thorough knowledge of the river in the vicinity of each crossing and of the bar itself, of the position of low-water channels and of the length of time they have maintained themselves in the past, and of the change taking place at present at all stages below moderately low water. In

order to obtain this knowledge, constant observations of depth, velocity, and direction of flow discharge, motion of sand (tailing of bar), etc., have to be made.

By commencing dredging operations on the most difficult crossings, before the river has declined sufficiently to impede navigation and while the velocity and scouring force of the current are still strong and actively at work defining the low-water bed, instead of waiting until the water is low and perhaps two or three subsidiary channels have formed, much advantage is gained.

It may be broadly stated that the dredge is used in nearly all river and harbor work of any magnitude in the world. In 1893, on



A DIPPER DREDGE AT WORK.

the Atlantic coast, seventy-five harbors were under improvement, sixty-six (88 per cent.) with the use of the dredge. On the Pacific coast of eleven harbors, six (54½ per cent.) required dredges. On the gulf coast all the harbors employed dredges, and on the great lakes about eighty-three (87 per cent.). On the inland rivers much the same practice is followed.

When the Mississippi river commission decided to employ dredges to improve low-water navigation, the first problem to be solved was that of the best form of dredge for the special duty of taking the sand from the crossings and moving it beyond the new channel quickly and economically. The dredges in use throughout the world were:

Scraper and sluicing dredges (including hydraulic and pneumatic sluices), dipper or scoop dredges, clamshell or grab dredges, bucket ladder or endless chain dredges, hydraulic dredges. Each of these types has numerous modifications to suit the special conditions and

purposes for which it is designed, differing in form of rake, jet, bucket, grab, hopper, machinery, hull, etc. In some there is a combination of two types, while in others the variation from the parent form is very marked, as in the pulsometer, pneumatic scraper, etc.

Scraper and jet dredges were generally used before the introduction of steam excavators, and were of a great variety,—rakes, harrows, plows, jet sluicers, propeller sluicers, etc.,—and even up to within a few years have been employed in this country and abroad. The principle on which they work is simply a scraping of the bottom by a directly-applied tool, or a water or compressed-air jet, leaving the force of the current to carry off the loosened material. The great difficulty of applying this machine successfully to the bars of the Mississippi is that the crossings are invariably too long.

If, in a heavily-charged stream like the Mississippi, a scraper, jet, or propeller is worked, the first result is the lifting of the material from the bottom and its transportation for a short distance by the natural force of the water, aided by the accelerated velocity due to the propeller or jet. At a very limited distance this natural force and increased velocity is absorbed or overcome, and the water, containing an abnormal load, soon drops it, moving the dredged material but a short distance lower down stream. The successful dredging with this type of machine depends on the velocity, the weight and comminution of the particles of material, and the distance it is to be moved; also on the irregularity of flow, which produces boils and upward currents conducive to the support of the material in suspension.

In sedimentary streams very fine sand is carried in suspension near the bottom, but the coarse sand forming the bar is rarely found in motion, except in the form of a wave having a forward motion of translation and rotation. The Mississippi bars are formed of sand waves that constantly move down the river, with sharp down-stream slopes, inclining gently above. The height of these waves is from 2 to 8 feet, and the length from 100 to 500 feet.

It has been demonstrated by numerous trials of these scraper dredges, on the lower Mississippi, that the material is too heavy, the current too light, and the crossings too long, to obtain satisfactory, or even moderately durable, results. At the mouth of the river numerous forms were experimented with, but without success.

In a small pass near Vicksburg the writer used one of the large hydraulic graders as a sluice dredger with poor results. Near St. Louis, in September, 1882, water jets were tried, and fairly good, but temporary, results were obtained. Four pile-drivers, containing pumping apparatus for jet driving, were lashed together, and, by means of lines to anchors, were drawn across the bar. A single jet was formed

by fastening the four jet pipes together and directing the streams forced through them against the bar. About 165 gallons of water per minute were discharged, and the depth of six feet was increased, for a good navigable width, to 8½ feet in 24 hours, but the depth was not permanent. In 1896 a jet dredge designed by Major Handbury was used on the river between St. Louis and Cairo at a number of shoals, deepening the channel from 1 to 3 feet. The plate on the opposite page shows the general arrangement of machinery, dimensions of centrifugal pump, and other details of the dredge.

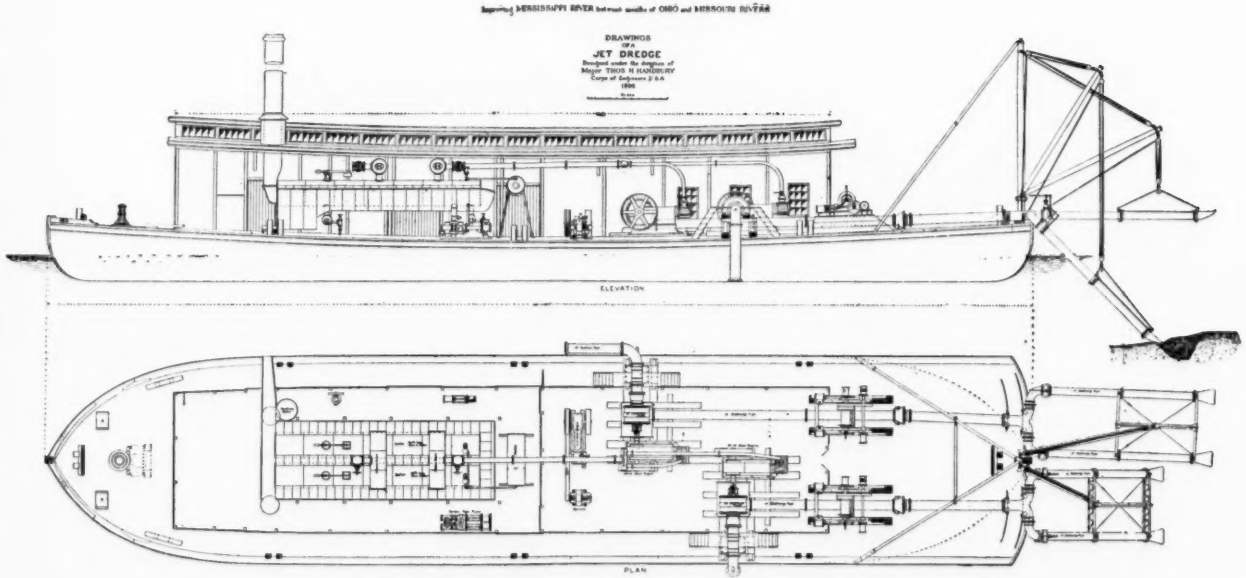
The scoop or dipper dredge, one of the most extensively used American designs, is always employed in connection with scows or other auxiliary conveyors. In wide roadsteads tugs or tow boats handle the scows. The larger scows, having a capacity of 500 cubic yards, draw, when loaded, 8 to 10 feet. Their use on our shoal bars would be prohibitory, therefore, unless moored behind or directly in the cut, with a constant probability of grounding. The larger scoop dredges have a capacity of more than 3,000 cubic yards per 24 hours, in good material, allowing for lost time due to breakdowns, handling scows, etc. (about 30 per cent. of the engine hours). The scoop dredge cannot be economically used with attached conveyors or hydraulic discharge. In coarse sand its capacity is reduced, owing to the impossibility of obtaining a well-filled bucket. Very large machines of this type would not be economical on a Mississippi river crossing.

The writer's experience with clamshell dredges in sand on the Mississippi is that on a compact bar their capacity is reduced over half, notwithstanding the application of teeth attachments and other contrivances to facilitate the penetration of the leaves of the bucket.

Near Vicksburg, in soft material, four-yard bucket machines moved about 3,000 cubic yards per 24 hours, digging in 40 feet of water,—not half of that amount when compact sand was encountered.

Like the scoop, this dredge requires the use of scows, and cannot be economically handled with attached conveyors. The loss of time due to repairs, handling scows, etc., is the same. Increased size of bucket and power of machinery adds little to its efficiency or economy, and for the purpose of dredging the Mississippi crossings it would give but mediocre results.

In the endless chain or bucket ladder machine much the same faults obtain. Bucket ladder dredges with self-contained hoppers are out of the question in this shoal river. Conveyors are successfully attached to these machines, and could be arranged on pontoons diminishing in height, but the distance of gravity conveyance would necessarily be small. The bucket ladder dredge used by the writer on



PLAN AND SECTION OF A JET DREDGE FOR THE MISSISSIPPI RIVER IMPROVEMENT.
Designed by Major Thos. H. Handbury, Corps of Engineers, U. S. A.

the Mississippi, like the single bucket machines, did considerably less work on encountering sand, possibly because of faulty construction of the particular machine used. This type of dredge could be used on the Mississippi bars, as it is in other portions of the world, in connection with a hydraulic conveyor, but it would not be as economical as the pump dredge, owing to the waste of power in raising to the top of the ladder material needed only at the elevation of the discharge hopper on deck. Webster says that the horse power required to raise the same material varies with the square root of the height from top of tumbler to surface of cut. The additional force exerted in a 300-yard-per-hour machine would be, therefore, about 15 h. p.

The difficulty of applying economically the above-mentioned dredges on the bars of the Mississippi lies not so much in their inade-

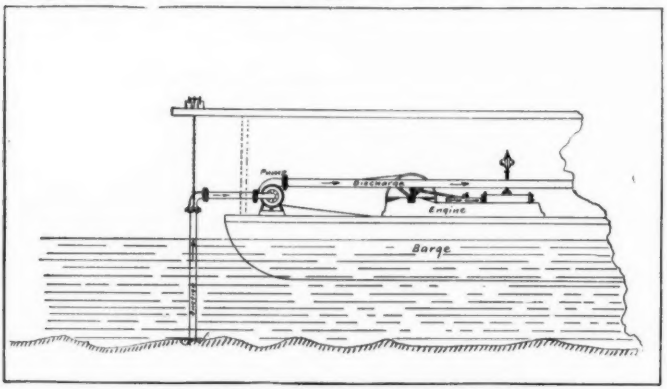


FIG. 1. SIMPLE FORM OF HYDRAULIC DREDGE.

quate excavating power as in the means of conveying the dredged material the necessary distance from the dredged channel. The real problem to be solved, therefore, is not alone that of excavation, but that of conveying the dredgings in this wide river subject to so numerous varying currents and strong winds. That the last and more modern type of dredge is better fitted for this work is self-evident. The reduction in lift and economy in operation on a large scale can not be doubted. Its double function of conveying as well as excavating fits it especially to this particular project.

The simplest form of the pump or hydraulic dredge is shown in Figure 1. Here we have a small centrifugal pump run by a belt from a small engine, a suction pipe of iron and rubber, and the discharge. When the pump is in action, the water and sand are drawn from the bottom, pass through the pump, and are forced through the discharge-

opening to a distance governed by the length of pipe, power of engine, capacity of pump, height of dumping ground, etc. The centrifugal pump differs from the ordinary reciprocating pump in that it is valveless and can take up and discharge large quantities of water containing large percentages of foreign matter without detriment to its parts. It consists of an iron shell or box, through which a shaft works; on this shaft and in the shell is a runner with blades, fixed or adjustable, forming a species of fan. On the shaft outside of the shell is a pinion or gear, by which connection is made with the engine. The water and material is taken into the pump at base or center of the fan wheel, and discharged at right angles to the suction and at the outer edges of the blades.

These pumps are made of various patterns, sizes, and capacities. One lately designed for the partial drainage of New Orleans is nearly 12 feet in diameter, and has a capacity of 1,900 cubic feet per minute.

It is claimed that Bamath, Hoffman & Schwartzkopf, a German firm, first patented the hydraulic dredge in 1856. Mr. Bowers, of California dredging fame, was also a pioneer in hydraulic dredging, but probably the first extensive application of the pump for transporting dredged material was as recent as 1867, on the Grand Canal at Amsterdam, the capacity of the pump being 1,330 yards per twelve hours, conveyed 900 feet and lifted 5 feet.

In 1872 General Gilmore, of the United States Engineer Corps, operated a crude suction dredge at the mouth of the St. John river, Florida, which moved 78 cubic yards per hour at a cost of about 31 cents per yard. In 1877 Captain Eads designed a hydraulic dredge, which worked at the mouth of the Mississippi. The Van Schmidt dredge of 1883 was the first complete hydraulic machine of large capacity and delivering design used in this country, and is a good illustration of the truth that "necessity is the mother of invention."

From these beginnings in the near past have been evolved the great hydraulic dredges, too numerous to mention, that have developed enormous capacity for excavation and delivery of material in sea, river, and canal, of various forms, from the stationary pulsometer used on the Potomac flats to the sea-going hopper dredge with mammoth rotary pumps, each varying in general design and detail with the conditions under which they operate.

The principles involved and the general mechanical design have varied but little in the hydraulic dredge. Changes in form of cutter or jet, position of machinery, and strength of material of construction have been made, but the great difference is in the enormous increase in size, capacity, and conveying power. Compare the 1,250 yards of

the Van Schmidt dredge of 1883 with the hopper pump dredge Brancker which, on the Mersey bar, in December, 1893, moved more than 22,000 tons (about 13,000 cubic yards) of sand per day.

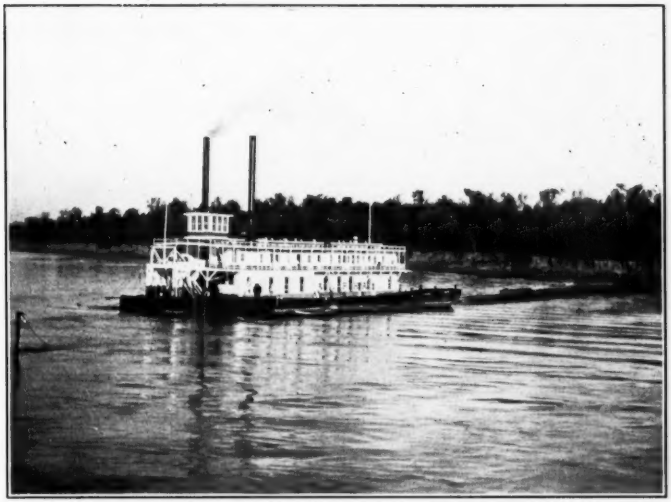
All over the world, where sand is to be excavated under water in large quantities and delivered from a half mile to ten miles or more, the hydraulic dredge is coming into use, either in the form of direct hydraulic force delivery dredges or hopper dredges with self-propelling machinery for transport to distant dumping-ground.

To move vast quantities of sand in a short time and deliver it from one thousand to two thousand feet from the channel required a new departure. In 1894 and 1895 a dredge was constructed by the commission, which, though a success, was but the step to the great hydraulic machine which followed the next year and with its consort kept the river open to navigation during the low-water season of 1896. The first dredge was named the Alpha. It was designed, after careful experiment and investigation had demonstrated the proper dimensions, power, and capacity for its machinery and frame, and has proved a success, though of much less capacity than the later dredge, Beta, which is probably the largest and most complete hydraulic excavator in the world to-day. The dredge Alpha at work is shown on page 469. The plant accompanying this dredge consists of one large steam tow boat, one pile-driver, and three barges. Her working force, including that of pile-driver and tow boat and survey party, is as follows:

Assistant engineer	1	Oilers	2
Master	2	Deckhands	8
Mates	2	Stewards	1
Steam engineers	4	Cooks	3
Master laborers	3	Waiters	3
Machinists	1	Laundresses	2
Carpenters	1	Surveyors	1
Strikers	2	Laborers	16
Firemen	6	Rodmen	1
Watchmen	2		

The report of her operations during the season of 1896 gives the cost of material (sand and gravel) moved as 4.3 cents to 12.1 cents per yard, the latter due to breakdown in runner of main pump.

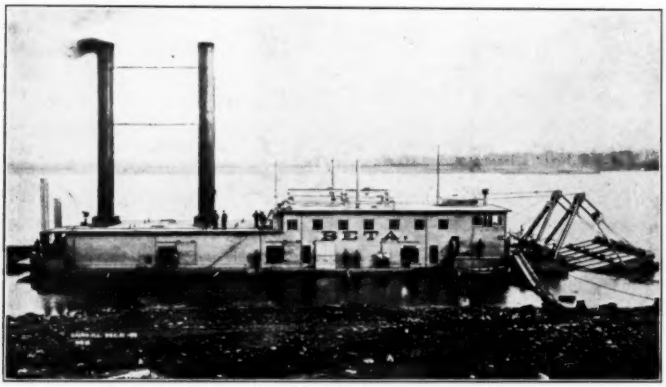
At one crossing, Compromise Bar, 77 miles below Cairo, the work consisted of 7 cuts, aggregating 5,405 lineal feet, the dredging time being 257¾ hours, and the average rate 21 lineal feet per hour. The amount of material moved was 80,555 cubic yards,—312½ cubic yards per hour. The cost was $3,473.68; average cost per cubic yard, 4.3 cents (sand and gravel).



U. S. DREDGE "ALPHA" AT WORK ON OSCEOLA BAR.

The Beta, though similar in general conception to other hydraulic dredges of the day, differs much in size and detail. Strictly speaking, it consists of two separate dredges on one hull, each with cutters and suction openings leading to a separate suction, large centrifugal pump, and discharge. The hull is of steel, 172 feet long, 40 feet broad, and from 7 feet 2 inches to 10 feet 10 inches in depth. About midship of the hull are located the two centrifugal pumps, one on each side, each, as stated, acting as a separate and complete hydraulic dredger. Each pump has a runner 7 feet in diameter and shaft 10 inches in diameter, with discharge 33 inches and suction 33¾ inches in diameter, actuated by separate triple-expansion engines with high-pressure cylinders 20½ inches, intermediate 33 inches, and low-pressure 38 inches in diameter, with 24-inch stroke. Each engine has jet condensers. Steam is obtained from four 375-h. p. Heine boilers, placed as shown in the drawing.

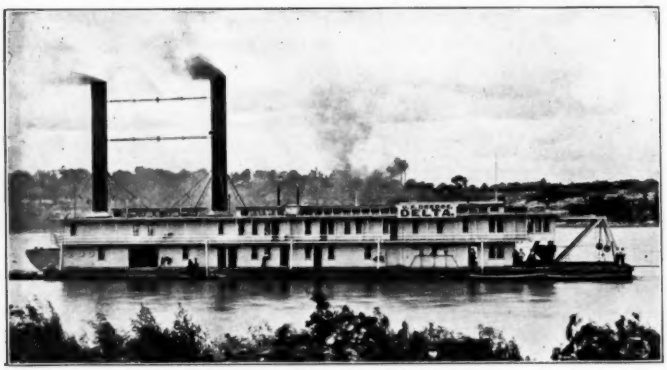
The six suctions, three to each main suction pipe, are 19½ inches in diameter. At the end of each suction pipe there is a revolving cylindrical cutter 5 feet in diameter, which cuts up the material to be inhaled by the great pumps. Each suction pipe is partially buoyed by a pontoon. The cutters are actuated by a small engine placed at the extreme bow of the dredge, which gives the cutters a speed of 25 revolutions per minute. The average speed of the centrifugal pumps, while working, is from 125 to 130 revolutions per minute.



U. S. DREDGE "BETA" BEFORE HER OFFICIAL TESTS.

The machinery for hoisting the suctions and cutters and regulating the movements of the dredge is shown just aft of the cutter engines.

Two vertical spuds for holding the dredge in place, and one pushing spud, are situated astern, and are moved by a small three-drum hoisting engine. The discharge or pipe conveyor is about 1,000 feet long, extending from the stern of the dredge to the dumping-ground. It consists of 50-feet lengths of 33½-inch steel pipe, resting on steel pontoons; the pipes have rubber hose connections, and are also connected and held in place by steel bars. When the dredge is operating, the pontoons are almost completely submerged. The power generated by the machinery on this dredge is more than 2,500 h. p.,



U. S. DREDGE "DELTA."

U. S. DREDGE "GAMMA" UNDERGOING EFFICIENCY TESTS.

and her weight is more than 1,000 tons. An electric plant of two 4,000-c. p. search lights and forty 20-c. p. incandescent lights enables the dredge to be worked continuously at night. The dredge has a traveling crane, blacksmith shop, and all the outfit required to work at a distance from point of supply.

The following is the manner of operating. After being placed at upper or lower edge of the crossing by her attendant steamboat, her spuds and cutters are lowered to hold her in place. Two clusters of piles are then sunk up stream on the line of proposed dredging extended, and cables are run from these piles to drums on the dredges. Piles are then sunk for guiding the line of discharge-piping and keeping the dump well removed from the cut. When these operations are completed, the dredge is ready for work; the spuds are raised, the suctions with cutters adjusted to the required depth, and the pumps and cutter engines started, the dredge being either

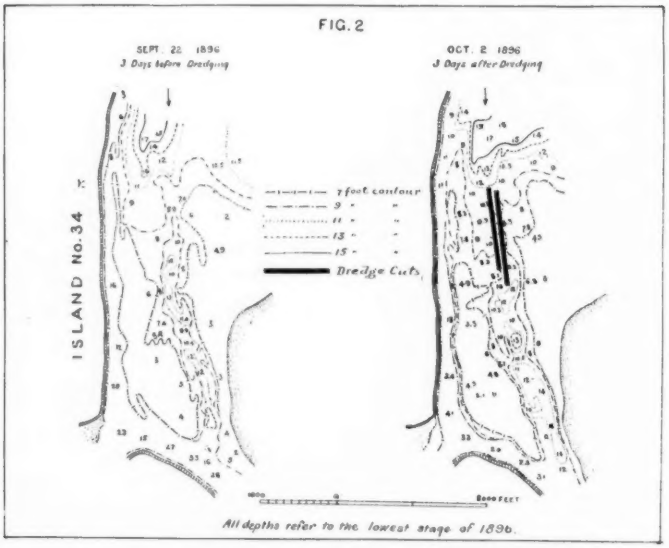


FIG. 2. THE IMMEDIATE RESULT OF DREDGING AT ISLAND 34.

dropped backward over the bar by rendering the cables or moved forward by means of the engines near the bow. The best method seems to be pulling up over one cut and dropping over the next, and so on, thus economizing time and obtaining the best results.

As the centrifugal force and reaction in the long line of discharge-pipe tends to give a forward and transverse motion to the entire attached floating plant when operating, a baffle plate is used at the end of the line of discharge to counteract this tendency.

The results of the first tests of this dredge were very astonishing and misleading. The average working capacity proved to be much lower than that which the short-time trials of the contractor had given reason to expect; yet it was far above the working capacity of other hydraulic dredges in the country.

The contractor's tests, which extended over less than ten minutes of actual operation, showed an average velocity of discharge exceeding 13 feet per second, a percentage of solids to gross discharge of 23, and a delivery of 4,921 cubic yards of sand per hour.

The plant for this dredge consists of two steam tow boats, one quarter boat, one machine shop, one pile-driver, and two barges.

During the season of 1896 this dredge was employed on seven

SUMMARY OF DREDGING OPERATIONS, DREDGE BETA, MISSISSIPPI RIVER, BETWEEN CAIRO AND MEMPHIS, DURING LOW-WATER SEASON OF 1896.

Place and Date.	Cuts.				Average Depth in feet.				Heads in feet.		Revs. Av. per Min.		Steam Pressure.	Distribution of time by hours.								Material Moved.		
	Number.	Total Length Feet.	Time Required Hours.	Rate ft. per Hour.	Suction.	Ahead of Dredge.	Astern of Dredge.	Material Removed.	Suction.	Delivery.	Pumps.	Cutter Engines.		Placing Plant.	Dredging.	Changing Cuts.	Repairs	Passing Boats.	Making up tow.	Towing.	Sundays and Holidays.	Total Time.	Dimensions of Superficial Area feet.	Cu. Yards.	Cost per cu. yd.
																									Cts.
Island No. 40, (211, L.) Aug. 31, to Sept. 24, 1896.*	10	5,945	121.0	49 1	15.3	9.2	13.4	4.2	14.4	19.1	129	120	161	53.5	121.0	25.2	12.7	1.0	39.0	104.0	19.0	375.5	800x2000	176,370	3.5
Island No. 34, (179, R.) Sept. 25 to 30, 1896.	3	2,265	66.0	34.3	15 6	9 5	13.5	4.0	15.2	21.6	134	125	165	16.5	66.0	5.0	14.5		6.5	25 5		134.0	800x2200	91,852	2 0
Osceola Bar, (164.5, R.) Sept. 30 to Oct. 9, 1896.	9	5,660	63.7	89.0	15 0	9.4	13.5	4.1	15.2	20.8	135	119	167	11.0	63.7	7.7	6.5		20.5	97 5	10.0	217.0	800x2300	65,555	3.6
Hathaway's Lower Crossing, (102, L.) Oct. 9 to 15, 1896.	16	1,2175	87.0	140.0	20 5	14.8	18.7	3.8	15.0	23.4	134	132	160	23.0	87.0				5.5	28.0		143.5	800x2400	80,592	2.0
Cherokee Crossing, (89 R) Second time. Oct. 15, to 24, 1896.	11	6,435	78.2	82.3	17.0	10.8	15.8	5 0	14.5	24.5	135	129	163	9.5	78.2		9.7		18.0	24.0		139.5	800x2500	62,000	2.8
Lower Point Pleasant, Mo, (79. 5, R.) Oct. 25 to Nov. 3, 1896.	13	9.415	109.2	86.2	16 0	7.7	13.5	5.8	15.2	25.6	136	131	162	13.0	109.2		62.7		7.0	24.0	24.0	240.0	800x2100	82,370	2.8
Cherokee Crossing, (89, R.) Third time. Nov. 4, to 13, 1896.	10	8,980	175.0	51.3	17.3	10.7	16.1	5 4	13.6	25.9	137	113	164	14.0	175.0		24.0		24.0		3.0	240.0	800x3900	128,148	2.4

* Capsizing of pipes delayed the work 224½ hours.

crossings; her record on one near Island No. 34, 179 miles below Cairo, was as follows. Two cuts were made nearly parallel, 40 feet apart, aggregating in length 2,275 feet; the time for dredging was 66 hours. More than half the work was done without the use of the cutters, the material being sucked up without previous agitation. The rate of advance was 24 feet per hour. The material was coarse sand and gravel. The suctions lowered to a depth of 15½ feet. The number of cubic yards moved was 91,852,—an average of 1,392 yards per hour. The total work, including towing, cost $1,793.42, or 2 cents per yard.

Figure 2 shows the channel at Island No. 34 three days before and three days after dredging. Sixty days later the depths on the crossing were less than they were before dredging, because of a wrong location of the cuts and repeated oscillation of the water surface in a short time. The diagram shows only the immediate effect of dredging. At points where the cuts were made in the natural channel, and not at variance with the direction of flow, the work was successful.

Table 1 shows a summary of the operation of this dredge during the low-water season of 1896.

The percentage of solids to total discharge during the season was about 12. On one crossing this dredge used 89½ bushels of coal per hour. The cost of dredging throughout the season was about 2¾ cents per yard of sand moved.

In addition to the two dredges mentioned, two more are completed and at work,—the Gamma and Delta,—and two more are under construction,—the Epsilon and Zeta. The Gamma has two suctions with jet agitators, her capacity being 800 cubic yards per hour. The Delta has mechanical agitators. The capacity of the Epsilon and Zeta is supposed to be 1,000 yards per hour, the former using jet, and the latter mechanical, agitators.

For work between the mouth of the Missouri and Ohio two more steel hull dredges, with water-jet agitators, are being constructed from Major Handbury's designs.

I desire to acknowledge the kindness of Mr. Ellis Thompson, United States assistant engineer, and Captain H. E. Waterman, secretary of the Mississippi river commission, in obtaining for me the photographs with which to illustrate this article.

REVIEW OF THE ENGINEERING PRESS

The Niagara Railway Arch.

ALTHOUGH much has already appeared in print about the new steel arch bridge over the gorge at Niagara, what may properly be called the official account has just appeared in the *Proceedings of the American Society of Civil Engineers* in the form of a paper by the resident engineer in charge, Mr. R. S. Buck.

Much of the interest in this work is due to the location, while the fact that the new bridge replaces the famous suspension bridge of Roebling, so long a feature of the view at Niagara Falls, has also added to the note of the structure. The old bridge, which had been standing 42 years at the time of its removal, had been repaired and strengthened several times, until nothing was left of the original structure but the cables, saddles, suspenders, and anchorages.

The new bridge is a two-hinged, spandrel-braced arch, of 550 feet clear span, there being no hinge at the crown, and it was built on exactly the same site as the old suspension bridge without interrupting travel. It was this question of erection which constituted the characteristic feature of the work and some account of it will be of interest.

"The deflection of the old bridge under moving load, the constant passing of trains, and the scant clearances at many points were considerations demanding close and constant attention; but as each difficulty was reached, it usually lost much of its formidable aspect. Besides, there was the comforting assurance that what had been accomplished with the old bridge under considerably less favorable circumstances ought to be accomplished again.

"Briefly, the principle of erection was to build out the two halves of the arch as cantilevers, anchored to the solid rock on top of the bluff, by means of adjustable anchor chains connecting with the arch at the top of the end post.

The anchor chains consisted of the top chords of the end spans, such of the eye-bars of the end spans as were adapted to the purpose, and such additional eye-bars and slabs as were necessary to complete the connections. The slabs were used as a matter of economy to serve as short eye-bars. The anchor pits were cut into the solid rock, back near the anchor walls of the old bridge. They are shafts 3 feet by 6 feet in section, and 19½ feet deep. Chambers were excavated at the bottom of sufficient size to admit the anchors. After the anchors, and the first two sections of the anchorage chain were placed, the anchor pits were filled with concrete to the top of the rock."

An adjusting toggle, operated by right and left hand screws was used and was found very effective in lifting and lowering the load in order to make the necessary adjustments.

It was originally intended to use an overhead cableway to convey and place the material, but owing to the large cost of a plant suitable for handling heavy and unwieldy pieces, travelers resting on the top chords of the arch were substituted. This erecting plant proved very safe and efficient. The two sides were entirely independent of each other, furnishing two points of progress, and when there was no outside cause of delay, the erection proceeded rapidly.

The material was conveyed to the travelers by means of trucks running on each side of the bridge. These tracks rested on the false work as far out as the end posts of the arch span, and from there to the center on the sidewalk brackets.

The erection proceeded from both sides to the center, and as the closure at the middle was reached some anxiety was felt, as the absence of a center hinge made much depend upon the accuracy of the workmanship. The distance was checked as closely as practicable when the half-spans were partly completed, and when

the center panels were placed there remained a space of 8 inches due to the extent to which the two halves of the arch had been drawn back to secure the necessary clearance for the placing of the final panels. The anchorages were then gradually slackened and the two halves of the arch allowed to come together.

Contrary to intention, the ribs met before the top chords, and hence the latter did not receive the compression for which they were intended. and it became necessary to force the top chords apart at the centre and insert shims, which was done without serious difficulty. The floor system was then raised to its proper position, and the removal of the old work and the placing of the new was done between trains, two panels at a time.

The completed work was tested by using two test trains as heavy as available, this amounting to 3500 lbs. of live load on each track per running foot, and the deflections observed were entirely satisfactory.

The manner in which the work was done is admirably illustrated in Mr. Buck's paper, both with photographs of the partially executed work and of the finished bridge, as well as strain diagrams and deflections, and the whole forms a valuable record of a noteworthy example of bridge construction.

Pig Iron Analyses.

THE use of chemical analysis in the iron and steel industries has proved of such practical importance that the work of the chemist has been extended to the analysis of pig irons for foundry use, and in a paper read before the Pittsburg Foundrymen's Association Mr. Thos. D. West discusses the subject in a very practical manner, showing the conditions under which the work of the chemist should be used in connection with foundry practice.

Some of the difficulties with which foundrymen have had to contend are very forcibly presented in Mr. West's paper.

"While the past four years have witnessed a greater revolution in foundry practice than any like period, methods of making mixtures were never in the plight in which we find them to-day. The recent introduction of chemistry in founding has brought a realization of the impossibility of accurately judging the grade of an iron from its fracture; yet there is still a prejudice with many against chemical analysis as a determiner of grades for making mixtures. It is unfortunate that there are features involved in such analyses that give the opponents of chemistry some ground for throwing doubt upon it. All improvements have to combat with more or less prejudice and difficulty before they can establish themselves. For this reason those who know from experience the value of working by chemical analyses should not be discouraged or sit still and let the retarding influences have full sway. The thing to do is to determine the factors that tend to prevent the general use of chemical analyses, and work to correct what needs correcting."

Among the points which Mr. West cites as tending to retard the introduction of the chemical method of determining the use of irons in mixtures are included: the absence in the use of uniform methods of analysis; the length of time which often elapses before the results of the examination of a given sample are returned; and the absence of any method of standardizing the drillings which are sent as samples.

By giving a number of tables of comparative results of analyses of drillings taken from the same pieces of pig iron, the differences between the results of the various chemists is clearly shown. "Considering that the drillings were taken from pig metal, which is not as good for checking purposes as clean especially prepared solid castings, and that there is no uniformity of method in analyses at the present time, the close results seen in the table are very creditable to the various chemists, and demonstrate that great care was exercised by all."

At the same time there were variations of sufficient importance to affect the results to a marked degree had these analyses been used for the purpose of making mixtures for actual foundry use. "When such differences are found in analyzing

pig metal where the greatest care and skill has been exercised, what are the chances to be run in accepting analyses made by the different rapid methods in the rush of every day furnace practice? Here we have, with the best of care and skill, a variation in the ingredient mainly due to lack of uniformity in laboratory methods and of a standard for analyses sufficient to affect two-thirds of all the castings made, causing them to be either bad, or ill-suited for the use for which they were intended."

The remedy for this state of affairs, in Mr. West's opinion, lies in the standardizing of methods not only of analyses but also of selecting drillings for samples. The idea of a central testing laboratory for standardizing laboratory work for furnace work and iron founding is suggested, and the usefulness of such an institution situated in the center of the Pittsburg district cannot be doubted, although certain practical difficulties in connection with its use can be foreseen.

Mr. West has certainly done well to call attention to this subject and it is to be hoped that his paper and the discussion which it has aroused may be the means both of securing more uniform and reliable analyses and of extending the chemical method of determining the suitability of various irons for practical purposes.

The History of the Stone Arch.

A VERY interesting historical sketch of the development of the stone arch, especially as applied to engineering work, is given in a paper by Professor Malverd A. Howe, read before the Engineers' Club of St. Louis, and published in the *Journal of the Association of Engineering Societies.*

Professor Howe rightly goes back of the once accepted idea that the Romans were the originators of the true arch, and shows conclusively that although many of the so-called arches of earlier times were really composed of horizontal layers, corbelled out, beehive fashion, with the faces dressed off to the intrados curve, yet there were true arches with radial joints known to the Egyptians, as well as the Assyrians, although neither of these nations, nor the Greeks appear to have trusted the arch sufficiently to use it in any works of magnitude that have come down to us.

"All records in the form of ruins, tablets, etc., fail to indicate that the true arch was employed in structures to any great extent prior to the sixth century B. C. The arched form, however, was quite common from earliest times, and ruins have been found in all portions of the world. There are a large number of examples of the true arch in bridge construction in China, as well as the primitive form of stone bridges without arches. The dates at which these bridges were constructed is unknown, but many believe that the Chinese built the true arch long before it was known to the western world."

"To the Romans we are indebted for the almost universal use of the voussoired semi-circular arch in bridge construction. From the second century B. C. until the fourth century A. D. the Romans built many magnificent stone arch bridges for roads and aqueducts, the magnitude of which has not since been equalled."

From a list of the principal works of this character it appears that between 312 B. C. and 226 A. D., sixty-three miles of arch bridges were built. An interesting fact in connection with the Roman bridges is that the centering was almost always supported upon large stones projecting from the piers below the springing line, as is still clearly shown in the cases of the aqueduct of the Pont du Gard near Nimes, in France, and in the aqueduct bridge near Segovia, in Spain.

Pointed arches for bridges came into use in mediæval times, as the Gothic arch developed in building construction, and one of the famous bridges of this type is the old bridge at Avignon, built by St. Benezet, of whom several variations of a miraculous legend are related in connection with the work, and throughout the middle ages the "Brothers of the Bridge" formed a semi-ecclesiastical, semi-industrial order by whom many important works were constructed.

The important arches of modern times are enumerated at some length in Professor Howe's paper, and much interesting information is given from various sources,

although as he truly says: "Data concerning even the more modern structures are very hard to obtain, and in many cases it is practically impossible to purchase photographs."

In conclusion the following general points are made:

The Romans first used the arch in the construction of bridges in the second century B. C.

Until about the thirteenth century the arch in bridges was of the circular form, and almost without exception it was semicircular.

The pointed arch was first employed in bridges about the thirteenth century.

In the fourteenth century segmental and elliptical arches were introduced.

At the present time the segmental arch is almost universally employed for long spans.

The Progress of Metallography.

WHEN a science makes such progress that it can furnish enough material to maintain a special publication devoted to the advancement of its interests, it is entitled to especial notice and demands a frequent hearing.

The science of metallography, or the study of metals through their physics and microstructure has become such an important feature in the art of testing that Mr. Albert Sauveur, of Boston, has undertaken the publication of a quarterly journal, entitled the *Metallographist*, devoted to the study of metals with especial reference to their physics and microstructures, and from the two numbers which have already appeared there seems to be no doubt either of the field for such a journal or of the ability of Mr. Sauveur and the colleagues associated with him to occupy it.

With but few exceptions, the most active workers in the field of metallography have been in Europe, rather than in America, and hence it is not surprising to find many of the papers in the *Metallographist* are translations of the memoirs and papers of such investigators as Osmond, Ledebur, Le Chatelier, Charpy, and Jüptner von Jonsdorff, but England and America are also represented by the names of Hadfield, Saniter, Roberts-Austen, Howe, Colby, and others; and if the high standard of the early issues of the quarterly is maintained by subsequent contributions and reprints from these and other writers of equal reputation the science of metallography will surely be well presented.

In his prefatory remarks, introducing the new review, Mr. Sauveur shows how important a thorough knowledge of the structure and behavior of metals is to the practical side of engineering work, and how investigations which at first seem to have but a laboratory interest may lead to most valuable results in practical engineering.

"The word metal at once suggests strength, solidity, durability, efficiency, usefulness, trustworthiness. As pure as gold, as true as steel, are well earned testimonies. An iron will stands for a will that does not falter. Reliableness is perhaps the quality of metals which should most endear them to us. From the knowledge that they will not fail us we derive a feeling of security, which leads us daily to intrust our lives to their stanch qualities, be it in our fast-moving trains, over our frail-looking bridges, in the vicinity of boilers and fly-wheels, or on the twentieth story of one of our modern buildings. And if rails and axles do occasionally break, if bridges and buildings occasionally collapse, if steam boilers explode, if a fly-wheel sometimes goes to pieces, could we only ascertain in every case the cause of the failure it would be invariably found that man, not the metal, was at fault. We should invariably discover that the failure was due to a faulty construction, to a defective process of manufacture, or to some injurious treatment of the finished product. We should find that man had violated some law of nature, which like all such transgressions, led to the inevitable penalty. Such instances of failures illustrate only more forcibly their wonderful efficiency, and the confidence which can be placed in metallic productions which have been created and erected in strict accordance with their chemical and phy-

sical properties and the general laws of nature."

At the present time there is an increasing activity in scientific metallurgical researches. "The metals and their alloys are being dissected, and the high-power objective, that wonderful instrument of research, is revealing to us their intimate structure, throwing a flood of light upon their constitution, chemical and physical, the practical as well as the theoretical value of which could hardly be overestimated. Their physics, hitherto much neglected, is being minutely investigated. Their thermal behaviour is being ascertained with a precision rendered possible only by the extremely delicate pyrometer of Le Chatelier. Their magnetic properties, their electric conductivity, their diffusion, their physical and mechanical properties in general are being investigated with a degree of accuracy never before attained. The chemist is energetically at work, in his endeavor to establish the true chemical relation between the metals and their impurities, and successful excursions are being taken in the domain of their proximate compositions.

As M. Osmond has aptly said, modern science is treating the industrial metal like a living organism, and we are led to study its anatomy, *i. e.*, its physical and chemical constitution; its biology, *i. e.*, the influence exerted upon its constitution by the various treatments, thermal and mechanical, to which the metal is lawfully subjected; and its pathology, *i. e.*, the action of impurities and defective treatments upon its normal constitution."

The Efficiency of Steam Jackets.

THE value of the steam jacket as a feature of steam economy has long been a question for discussion by mechanical engineers, and the transactions of engineering societies show the very decided and yet opposing views held by prominent members of the profession upon this subject.

Especially in connection with multiple-expansion engines has the economy effected by the steam jacket been a matter for question, and, whenever tests could be so made as to add to the stock of information on this point, the results have been carefully examined and discussed.

The latest contribution to the data upon the economy of steam jacketing is found in the report of the test of the compound engine at the Grosvenor-Dale Mills, made by Mr. George H. Barrus, and reported in the *Engineering Record* with an editorial discussion.

According to Mr. Barrus's figures, the economy of steam due to the use of the jackets was about 2 per cent., including the reheating of the steam in the intermediate receiver.

"An economy of 2 per cent. in favor of jacketing and reheating is hardly worth considering, when we take into account the extra complication and possible increase in the danger of breakage which are incident to their use." By figuring the saving of 2 per cent. on the total fuel-consumption, and comparing the amount with the estimated cost of the jackets and receiver, the *Engineering Record* shows that the interest on the outlay practically equals the value saved by the performance, leaving no real gain, and, it may be added, this agrees well with results obtained elsewhere.

The behaviour of the jacket is interesting to consider. "If, in the recent tests, we analyze the diagrams and compare one set with the jackets in use with another set with the jackets not in use, it appears that there is a very marked difference, and that the failure of the jacket to show a greater advantage is not due by any means to inaction. The noticeable feature in the operation of the jacket is that it increases the work done by the low-pressure cylinder. In the two comparative trials the horse-power developed by the low-pressure cylinder with the jackets in use was 29 per cent. more than that developed by the high-pressure cylinder. When the jackets were shut off, the increase in the power developed by the low-pressure cylinder was only 7 per cent. of the power developed by the high-pressure cylinder. Furthermore, the steam accounted for by the diagrams when the jackets were in use

was much larger in the low-pressure cylinder than in the high-pressure cylinder; while, on the contrary, when the jackets were shut off, the steam accounted for was much less in the low-pressure cylinder than in the high-pressure cylinder."

There is no doubt that these results will do much to turn the attention of engine designers to other methods, and it is possible that the very moderate steam economy shown by the use of the jacket will help to advance the revival of superheating, to which many are already beginning to turn. It is very probable that a satisfactory superheater could be constructed at a cost but little, if any, greater than that of the jackets and reheater, while the experiments and tests by many competent observers have demonstrated that an economy of 15 to 20 per cent. is shown by a superheating quite within the limits of daily practice.

Power From Blast-Furnace Gases.

THE possibility of generating power from the discharge gases from blast furnaces, to which reference has been made here already, is continuing to attract attention, and an editorial in the *Iron Age*, in discussing the paper presented by Herr Lürmann before the *Verein Deutscher Eisenhüttenleute*, takes the position that, "as matters now stand, furnace managers in the United States will not rush into this field, however temptingly held out to those who may admire the gas engine, but know little concerning the conditions governing blast-furnace work."

The main points brought out by Herr Lürmann were, first, that blast-furnace gases contain dust, metal, and injurious vapors, unfitting them for use in the cylinders of gas engines, and, second, that, if all blast-furnace operators should take up with the idea, the builders of gas engines would be totally swamped with orders, and that it would take years to supply the demand!

It would have given a fairer idea of the position of the German ironmasters on this subject, if some of the points made in the discussion of Herr Lürmann's paper had been given, for it appears that his views were by no means generally accepted by his hearers.

So far as the sad outlook of an enormous demand for gas engines is concerned, this curious objection was promptly met by Herr Schum, of the Otto works at Deutz, who called attention to the fact that every steam-engine works in the empire could undertake the construction of gas engines at short notice, and that there was little reason to fear that the machine shops of Germany would prove unequal to any demand upon their productive capacity.

The views of so experienced engineers as Körting, Helmholtz, and Schürmann, were at variance with the position of the author of the paper, and showed that the quality of the gas could readily be improved by proper engine construction, and that the dust and impurities could readily be separated.

It seems only natural that so radical a proposition as that of using this hitherto wasted source of power should pass through the customary routine of opposition, toleration, and adoption, but, when the advantages are so apparent and the opposition so feeble, it is evident that the stage of adoption cannot be long delayed.

In another place in this issue will be found a very complete discussion of the whole subject from the pen of Mr. W. H. Booth, than whom no one is better fitted to appreciate its importance and grasp its difficulties; when his full exposition is placed in comparison with the objections of Herr Lürmann, it will not be difficult to come to an intelligent conclusion concerning the value of the idea.

The matter of the gas engine itself is already being solved on both sides of the ocean, and the large gas engine will promptly be in evidence so soon as there is a ready market for it. This subject, too, has already been fully discussed in recent issues of this magazine. When, the blast-furnace men get ready to use their present waste products in motors of large or small size, the ranks of the builders of gas engines will be rapidly reinforced from the ample machine-shop capacity of the entire United States.

Refractory Surfaces in Furnaces.

IT is a common mistake in steam boiler design to assume that the best results will be obtained by bringing the heating surfaces of the boiler close to the fuel bed, with the idea that in this way the greatest amount of heat will be abstracted from the burning fuel.

An article by Mr. W. H. Booth, in the *American Machinist*, shows very clearly the fallacy of this idea, and states the conditions of favorable combustion in boiler furnaces.

"There is one grand principle: No substance will ignite unless first raised to a certain temperature, and it will not burn freely unless allowed to get hotter than the minimum temperature of ignition. Applied to coal and coal gas, we may set down the minimum temperature of ignition at, say, 800° F., and the minimum temperature for continued combustion at 1,000° F. A full furnace temperature may well be 2,500° F., and this is ample to throw off large volumes of gas from freshly-charged fuel and to set it burning freely. But, if we allow these freshly-ignited gases to flow among a nest of cold water tubes, the gas will be so cooled that its further combustion will be either stopped or rendered very imperfect. An example, well known in the laboratory, of cooling a flame to the point of extinguishment is the placing of a coil of platinum wire round a candle flame, which may thereby be cooled out altogether."

This principle is well borne out by the excellent results which have been attained by boiler settings in which the furnace and combustion chamber are altogether removed from the boiler itself, being placed in front, the burning fuel having an arch of fire-brick over it, absorbing and radiating heat and permitting a maximum furnace temperature to be attained. The intensely hot gases can then come into contact with the relatively cooler boiler surfaces without detriment, as the combustion has been fully effected and cannot be checked by any cooling action.

A similar effect can be obtained in the case of internally-fired boilers by partially lining the firebox with firebrick.

"Experience alone can decide how much brickwork should be used. It may be placed so as to afford a cellular structure, the plates being exposed at the openings only. It may be placed as a series of narrow rings, each of which will stop the flow along the plates of any stream of quenched gases, and compel them to pass over regenerating surface. The use of unlined furnaces with blocks of firebrick in the flues beyond the boiler is, to my mind, wrong. It is an endeavor to remedy, by the giving out of heat taken up from a bright and clear fire, a fault which should not have been made. It is, in fact, an attempt to return to the gases heat which ought not to have been abstracted from them in the furnace. Therefore the system is faulty. The refractory material should be in the furnace, and the gases should be left to remain hot as long as necessary for perfect combustion, instead of being too promptly robbed of heat, only to be reheated beyond the bridge, where, if kept originally hot, they would complete their combustion, and only then be fit to be cooled by water contact."

Liquefied Air.

WE have already noted in these columns some of the properties of liquefied air as produced in Germany by Professor Linde, and since then the subject has been brought into prominence in the United States by Mr. Charles E. Tripler, of New York.

Mr. Tripler's experiments and apparatus are very fully described in an article in *Engineering News*, in which it is shown that the apparatus is practically identical with that used by Linde, the question of priority being a matter of dispute, which time will doubtless decide. Leaving this feature for the present, the principal questions in the matter for solution are, first, the cost of production of the liquefied air, and, second, the possible uses for it.

The first thing required for the production of liquid air is a reduction to the critical temperature, above which it is impossible to liquefy it by pressure. This critical temperature, according to Professor Dewar, is about —220° F., and, when this is attained, the air can be liquefied by a press-

ure of about 1,500 pounds per square inch, although in practice the gauge shows from 2,200 to 2,300 pounds. The low temperature is obtained by compressing a portion of the air and permitting this to expand in an annular space about an inner chamber also containing compressed air, and, as the pressure of more than 2,000 pounds is above that necessary for liquefaction, the liquid forms as soon as the critical temperature is reached.

Many details, including the purifying of the incoming air, and the removal of the heat of compression, etc., require attention, but the fundamental principles are as stated.

According to computations, based both on the experience of Mr. Tripler, and the figures of Professor Ewing from Professor Linde's work, the production is between 0.7 and 0.8 pounds per h. p. hour, so that the actual cost is about 15 cents per gallon, not including interest, rent, insurance, or depreciation of plant.

Turning now to possible applications of liquid air, there seem at present to be but two available, apart from lecture-room experiments and laboratory work. The first and most obvious is that of refrigeration. "For ordinary refrigeration it is quite unlikely that the ammonia machines at present in use will be supplanted, as tests have shown them to be more efficient than any form of compressed-air machines; but for special refrigerating purposes, where very low temperatures are desired, or where it is desired to store a large amount of refrigerating effect in a small space, liquid air would seem to be admirably adapted."

"The most important by far, however, of the probable future uses of liquid air appears to be the storage of power. At the present time there are only two methods known to engineers by which considerable amounts of power can be stored with apparatus of moderate weight and bulk. These are the electric storage battery, and compressed-air tanks, both of which have only been developed so as to be commercially practicable within the last few years. It now seems probable that in liquefied air we are to have a new method of storing power, considerably more expensive, it is true, than the older systems, and returning a smaller proportion of the power originally applied; but having the very great advantage of storing several times as many foot-pounds of energy in a cubic foot or a pound as the older systems."

Very much will depend, of course, on the efficiency which may finally be attained in its production, and the consequent reductions in the cost of the process. The success already attained, however, makes it reasonable to expect that the near future will see liquid air used to store power for such purposes as torpedo propulsion, where cost is a secondary consideration, and perhaps for the propelling of bicycles and motor carriages, and similar purposes where the storage of the maximum power with the least weight and bulk is more important than expense."

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Underground Water-Supplies.

THE use of wells as a source of water-supply is never to be recommended, but in many cases there is no other available source, and, with certain precautions, water obtained from underground channels may be used with far more safety than is generally supposed possible.

In a paper read before the Society of Engineers by Dr. John C. Thresh the protection of underground water-supplies is discussed in a very thorough manner, and a number of valuable points are brought out.

While the value of chemical and bacteriological analysis is admitted for many purposes, it is of little avail for purposes of practical protection, since waters chemically above reproach may be ready carriers of disease, while the bacteriological examination can reveal the deadly bacilli only after the pollution has occurred and much of the harm has been done.

While the water obtainable from underground supplies has the same origin as that of rivers and streams,—*i.e.*, the rainfall,—the manner of protection against pollution is different in the former case from that which is obvious in the latter. The impossibility of insuring against contamination all the water which may ultimately enter a well renders it necessary to know whether natural filtration will take place in a degree sufficient to remove the bacilli of disease.

The investigations of Pettenkofer, the researches of Hauser, and the experiments of Martin and Robertson, tend to prove that typhoid and cholera bacilli can flourish only near the surface and in a polluted soil, and Fraenkel shows that the subsoil is free from germs even when the soil above has been contaminated for a long period. Dr. Thresh's own investigations in sand at various depths show that very few organisms are found at a depth of four feet, none occurring at a depth exceeding five feet. In fissured strata, of course, these conditions do not hold good, and in such cases the inflow from possible sources of contamination must be carefully prevented. The principal difficulty with shallow wells, such as supply water for nearly one-third of the population of the British islands, lies in the absence of precautions against pollution, but there is no good reason why this should be so. Although the use of water from shallow wells sunk in populous neighbourhoods is not to be commended, there is very little doubt that in many such places a perfectly safe water-supply may be derived from the sub-soil. The essential features are the prevention of the entrance of water from any point less than six feet below the surface, and the absence of any cesspool within the area of the cone of drainage, say, from forty to sixty feet distant.

For deep wells from which a large supply is to be drawn we cannot do better than to repeat Dr. Thresh's directions as to the protection which should be given to the well.

"There should be an area of ground around each well under the absolute control of the purveyors of the water. The well should be constructed so as to admit water only at the lowest point possible. If the pumping machinery is in or over the well, care should be taken to prevent dirt of any kind, especially from the workmen's boots, from reaching the water. The immediate vicinity of the well should either be uncultivated or laid down to grass, but not fed. An outer ring should be similarly laid down, but cattle may be permitted to feed thereon. These two rings may be called the inner and outer protective areas, and the inner ring should be so protected that no one can enter 'except on business.' The area of this inner ring should be, at least, as large as the area of the cone of depression produced by the pumping. For example, suppose that 45,000 gallons are being pumped per day

from a sandy subsoil, and the depression of the water-level in the well caused by the pumping is 9 feet. Each cubic foot of the saturated sand would yield about 1½ gallons of water. To yield the 45,000 gallons, therefore, 30,000 cubic feet of the subsoil would be drained. The cone of depression having a depth of 9 feet, the area of its base would be 1,100 square feet, representing a circle with a radius of 17 feet, the well being at the centre. The cone, however, has not straight sides, and, to be perfectly safe, therefore, a radius of 30 feet had better be allowed. The outer protective area should have a radius of 70 to 100 yards, if possible."

If the well is thus protected, and chemical and bacteriological tests are made at frequent intervals as a precautionary measure, the probability of disease from such a source of water-supply is very remote.

Possible Economies in Steam Auxiliaries.

ALTHOUGH the wastefulness of much of the auxiliary machinery both in vessels and in shore power plants has been known for a long time, it is only recently that definite efforts have been made to reduce the losses and attain a measure of economy in this direction at least approaching that of the main engines.

In the last issue of this magazine the subject of a central electric power plant on shipboard was ably discussed by Mr. Shepard, and a review of the tests of the machinery of the Minneapolis was given. The matter is also being agitated in the British navy, especially in connection with the cruise of the Powerful and the tests of the Terrible and Diadem.

There is a general unanimity as to the fact of wastefulness, but a decided difference of opinion as to the best methods of improvement.

Mr. Shepard has shown that there are many objections, both financial and operative, against the plan of a central electric plant, and it is possible that compressed air or hydraulic power would be free from many of the objections which attach to electricity for this purpose.

It may be, however, that there is sufficient room for improvement with the present system of steam auxiliaries to render any radical change unnecessary. There certainly should be, when we remember that on the Minneapolis steam-consumptions of 100 to 300 pounds per h. p. per hour were the rule, and 55 pounds was the minimum.

In the discussion upon the trials of the Diadem at the meeting of the Institution of Naval Architects this question of losses at other points than the main engines was the principal topic, and some interesting points were brought out. One of the greatest difficulties in connection with many of the engines is the necessity of making the cylinders large enough for the maximum duty, when for the greater part of the time they are operated under very light loads. The use in the auxiliaries of pressures as high as those best adapted for the main engines is also a cause of loss, as the absence of any reasonable degree of expansion in the small cylinders, and the presence of large clearances cause a large proportion of energy to pass out with the exhaust.

In view of the fact that there is so little expansion of the steam in the cylinders of the auxiliaries, a suggestion made by Mr. Yarrow is in point. He proposed that the exhaust from the auxiliaries, instead of being condensed or wasted, should be delivered to the receiver of the main engines communicating with the low-pressure cylinder, where it would have an opportunity to do work while expanding. The principal difficulty of this plan, as Sir John Durston points out, is that it would interfere with the handling of the main engines.

Another method of economising, and one which has been suggested both in England and in the United States, is to use the exhaust steam from the auxiliaries for the purpose of heating the feed water; in this way, indeed, much of the heat could be retained.

The true principle, however, lies in the improvement of the auxiliaries themselves, as regards economy in performance; in this direction there is ample room for saving. Pumps should not be permitted to have a variable stroke, but should oper-

ate at a minimum clearance at all times. Engines which operate at little or no expansion should be fed with steam at a reduced pressure, and should not be allowed to use direct boiler pressure of 180 to 200 pounds.

In many cases where more than one machine is required different sizes could be installed, so that light work might be performed by a small engine running at full capacity, and the larger one used only when there was enough work to require it. Far more care should be taken to prevent pipe condensation; all pipes should be so well covered that the loss from this source would be reduced to a minimum, the discomfort from heat being also diminished.

In these and other ways the losses now occurring in the auxiliary machinery could undoubtedly be so reduced as to give a great measure of immediate relief without involving the necessity of a change so radical as the introduction of any form of central power plant.

Feed-Water Heating with Live Steam.

THE advantages of heating the feed-water for boilers are well known and generally admitted, but usually it is attempted to use for this purpose some source of heat which would otherwise go to waste. In nearly all of the feed-water heaters in practical use the heat is either employed in the waste gases on their way from the boiler to the chimney,—the so-called economisers,—or else is abstracted from the exhaust steam.

In the former case a high degree of heating may often be obtained, and the economiser is sometimes regarded as a sort of preliminary boiler, following out the principle laid down by Rankine that the coldest water should meet the coldest gases and proceed gradually to the hotter surfaces. When exhaust steam is used, however, it is not practicable to obtain a higher temperature than 208 to 210° F., unless a sufficient amount of back pressure is permitted in the engines to obtain exhaust steam of a temperature higher than that of the boiling-point of water.

Various plans have been made, however, to use live steam taken directly from the boiler, and therefore of a temperature corresponding to the boiler pressure, and with this plan the feed-water may be made much hotter than with any form of exhaust-steam heating device.

Theoretically there does not seem to be any reason for economy in this proceeding, for whatever heat is given to the water is abstracted from the boiler, which is like taking money from one pocket to put it in the other. Experience has shown, however, that there is a decided advantage in thus using live steam to heat the feed-water, and in a recent number of the *Engineer* the possible reasons for this apparent anomaly are discussed.

The usual method of computing the gain due to heating the feed-water is based upon the actual number of heat units supplied, and upon this basis the maximum possible gain within the temperature limits of ordinary practice is about 15 per cent. When, several years ago, Mr. John Kirkaldy stated that the use of live steam for heating feed water showed a gain decidedly greater than that which had been considered possible, there was a general feeling of incredulity; but, since many practical tests and years of undoubted experience have sustained the facts, a satisfactory explanation of this curious action is now thought to be in order.

Both Professor Unwin and Mr. Macfarlane Gray have expressed opinions upon the subject which seem worthy of consideration, and which also remind us that there are matters to be taken into account other than mere temperature differences, when the generation of steam is to be considered. In explanation of the increased economy due to live-steam heating, Mr. Macfarlane Gray says that water at the same temperature as the steam is more mobile than cold water, circulates more freely, and is more efficient in taking up heat from the metal surfaces. A similar view was expressed by the *Engineer* several years before, as the following quotation will show: "It is clear that the efficiency of a boiler working with hot feed will be greater than the efficiency of a

boiler working with cold feed. The Kirkaldy heater is supplied with steam from a boiler with feed-water at a very high temperature indeed, and the efficiency of each pound of fuel employed to heat that feed will be greater than it would be if the steam were supplied by a boiler working with cold feed. Each unit of heating surface will probably, in a given time, transmit about the same quantity of heat, whether the water in contact with it is 200° or 350° or even hotter; but it is obvious that, if the water be very hot, more steam will be produced in a given time per unit of surface than if it is cold. The result is equivalent to an augmentation of furnace heating surface."

It has been long a practice in the United States to use live-steam feed-water heaters, not so much for the purpose of effecting a direct economy in boiler performance as to purify the feed-water by precipitating the sulphates which may be contained in it. It has been reasoned that at least there could be little or no loss, since the heat is ultimately all returned to the boiler, while the freedom from scale in the boiler is considered an important advantage. It is a matter of experience that such heaters are not wasteful, and hence this experience is at least not opposed to the conclusions of the *Engineer* and of later investigators.

Evaporation in Water-Tube Boilers.

THE question of the behaviour of the water in modern small-tube boilers has been discussed from various standpoints, and attempts have been made with more or less success to determine from experiments with glass tube models just what actually occurs with various forms of construction.

Among the experimenters no one has been more indefatigable than Mr. Yarrow, and some of his experiments as to the necessity or otherwise of using downcomer pipes have generally been regarded as conclusive.

Mr. Yarrow's latest experiments are given to the profession in a paper read by him before the Institution of Naval Architects, and published in *Engineering;* and, from the fact that the tests which form the basis of the paper were made upon a full-size working boiler, they are of greater value and interest than if a small model had been used.

The present tests were made with a view of showing the effect upon the evaporation of changing the point of introduction of the feed-water, and, although the specific details apply to the boiler with which Mr. Yarrow's name is associated, yet the principle is true for other forms, and, indeed, was enunciated long ago by Rankine, although often ignored by steam-boiler designers.

The experiments consisted in making careful evaporation tests, first, with the feed introduced in the ordinary way, mixing at once with the water already in the boiler, and then, by partitioning off three outer rows of tubes on each side by means of diaphragms in the bottom pockets, delivering the feed into these outer tubes at the bottom and requiring it to pass through them before it mingles with the main volume of water.

Temperatures at various points were carefully taken, using the Le Chatelier pyrometer, so that the conditions under which the water was evaporated were obtained, the analyses of the flue gases showing the excellent character of the combustion.

The results of the tests are very clearly shown in a graphical diagram, curves giving the evaporation per pound of coal at various rates of firing. The advantage of thus feeding the water into the outer tubes first is shown by the diagrams to amount to nearly 20 per cent., being nearly 12 pounds of water per pound of coal for the new method of feeding as against 10 pounds for the usual method, diminishing somewhat as the boiler was forced above its normal capacity.

The principle involved in feeding a boiler in this manner is much the same as that involved in the use of an economiser in the flue, exposing the cooler water first to the action of the cooler gases; and the results of these trials confirm the soundness of this principle and the wisdom of applying it.

Telegraphy Across Space.

WE have heard much during the past few months about the so-called "wireless telegraphy," both as to methods and results, with some admixture of the "horrid wrangling about priority" which inevitably accompanies the development of any new subject.

Among the various articles upon this subject it is refreshing to meet with so clear and satisfactory a paper as that presented before the Society of Arts by Professor Sylvanus P. Thompson, and published in the *Journal* of the society.

Professor Thompson begins by objecting to the term "wireless," and shows that there can be no such thing as wireless telegraphy, since base-line wires of considerable length must be used, even when there is no direct-connecting wire between the two stations. The methods of telegraphing across space are divided into three classes, as follows:

(1) Conduction methods;
(2) Induction methods;
(3) Wave methods.

Those of the first class depend upon the use of water or earth as a means of conducting a fraction of the electric current from the base-line at the sending end to the base-line at the receiving end.

Those of the second class, or induction methods, are better known in connection with the successful attempts of Phelps, Gilliland, and Edison to telegraph to or from moving trains, and the principles involved are the same that sometimes permit telegraph or telephone messages to be overheard in instruments upon totally disconnected lines, and that explain the interruption of telephone communication with a roaring or buzzing noise caused by induction from neighbouring wires.

At the present time, however, practically all the investigations are being made with methods of the third class, or wave methods, and it was of them that Professor Thompson principally spoke.

The predictions of Clerk-Maxwell and the experimental researches of Hertz first called attention to electromagnetic waves, and, after the death of Hertz, the work which he had begun was carried on by a number of investigators, among whom Professor Lodge, M. Branly, and Sig. Marconi are best known. Hertz had first pointed out the existence of a true travelling wave. Hitherto there had been known inductive actions reaching out from wire to wire and falling back when the exciting cause died away. The true electric wave, however, when once started on its path, did not collapse into the wire when the spark ceased, but, on the contrary, went travelling on. Such a wave, Hertz showed, could be started by a simple apparatus called an "oscillator," consisting of two metal plates or conductors connected by a conductor interrupted at one intermediate point by a "spark gap," the oscillator, on the appearance of each spark, emitting a train of waves into the surrounding space.

To receive such waves some form of "detector" was necessary, and many forms have been proposed. The detector now found most effective is the so-called coherer, suggested by Branly and developed by Lodge, and consisting of a small glass tube partly filled with loose metallic filings, such as iron or silver, joined in the circuit.

The passage of an electric wave throws the coherer into the conductive state, making the connection with a local circuit much as it is made in the case of a telegraphic relay, and, after the passage of the wave, the coherer may be thrown into the non-conductive state by tapping or jarring, —an operation easily performed mechanically.

With these simple pieces of apparatus Lodge first sent messages a few hundred yards, followed by the experiments of Marconi, who, with the assistance of the British telegraph department, sent signals from Lavernock Point to Bream Down, a distance of about nine miles, and subsequently at Spezia, over the open sea, maintained communication between points about 11 miles apart.

In Germany Professor Slaby, using the Branly-Lodge coherer and base-lines 200 to 950 feet in length, communicated over an open stretch of country from Rangsdorf to Schoneburg,—a distance of 13½

miles,—and he is of opinion that over open sea a much greater distance appears to be attainable for a given base-line than over land.

In conclusion Professor Thompson says:

"It has been shown that there are three general methods of transmitting electric signals across space. All of them require base-lines or base-areas. The first—conduction—requires moist earth or water as a medium, and is, for distances under three miles, the most effective of the three. The second—induction—is not dependent upon earth or water, but will equally well cross air or dry rock. The third—electric wave-propagation—requires no medium beyond that of the ether of space, and is, indeed, interfered with by interposed things, such as masts or trees. Given proper base-lines or base-areas; given adequate methods of throwing electric energy into the transmitting system, and sufficiently sensitive instruments to pick up and translate the signals,—it is possible, in my opinion, so to develop each of the three methods that, by any one of them, it will be possible to establish electric communication between England and America across the intervening space."

The Simon-Carves Coke Oven.

NOTWITHSTANDING the fact that in the ordinary beehive coke oven there is an entire loss of several valuable bye-products, by far the greater number of coke ovens in use in all parts of the world are of this primitive type.

Numerous attempts have been made to produce successful retort ovens in which the bye-products can be saved, and prominent among these may be named the Semet-Solvay, Otto-Hoffmann, Festner-Hoffmann, Hüssener, Seibel, and Simon-Carves ovens. Among these the Simon-Carves oven has been found to yield excellent results in practice, and from an account of several installations of this type of oven, in a recent issue of the *Iron and Coal Trades Review*, we give some details as to performance and economy.

The beehive oven, as is well known, cokes the coal by "internal" combustion, the fuel being the gas distilled and a small portion of the carbon, the admission of a sufficient quantity of air being also necessary. By the Simon-Carves system the coal is converted into coke by heat transmitted to the coal through the oven walls, such heat being obtained by burning the gases from the coal, as they circulate outside and along the side and sole of each oven, after the tar, benzol, and ammonia have been abstracted. All air is excluded from the inside of the oven, so that no carbon can be burned, and heat is applied externally, as to a closed retort.

The bye-products are secured by drawing the distilled gases from the retorts by exhausters, the tar and ammonia being collected partly in hydraulic mains and partly in condensers and scrubbers, and the benzols and light hydrocarbons in oil scrubbers, after which the gas is led back to the flues around the exterior of the retorts, there to be burned as fuel.

When the coke is ready to be discharged from an oven, the coal for the next charge is got ready over the charging holes, situated above the retort. The two end doors are then opened, and the mass of coke pushed out from the back of the oven on to the coke platform by means of a ram worked by a portable steam engine running on rails in front of the ovens. As soon as the coke has been discharged the end doors are closed, the charging holes are opened, the coal is charged, and the coking process begins afresh.

Besides the value of the bye-products recovered by the use of retort ovens, there is a further gain in the increased product of coke from a given quantity of coal. Out of 100 tons of Durham coal about 75 tons of coke are obtained by the Simon-Carves process, whereas by the old beehive process the yield does not exceed 60 tons, and all the benzol, ammonia, tar, etc., are lost.

A large number of these retort coke ovens have been installed at Durham, and others are soon to be erected. Notwithstanding the greater first cost of the plant, there seems every reason to believe that the increased output of coke and the realisation of the value of the bye-products will return a handsome profit on the outlay.

The Progress of Electric Traction.

As the statistics of tramway construction and operation for the past year begin to be made public, comparisons between various countries can be made, and an outline of probable progress for the future mapped out. A general review of this subject, with especial reference to electric traction, is given in the *Railway World*, and some of the conclusions drawn from the tabulated figures are very interesting.

Referring first to Europe, including both the United Kingdom and the continent, the development has been rather in point of equipment than in mileage.

"The relatively light increase of lines as compared with the increased capacity of the power stations and motor cars indicates that the development of electric tramways has principally occurred in the larger cities and systems. Germany stands at the head, with a length of 386 miles and 1,631 motor cars, as against a length of 538 miles and 1,469 motor cars in all other European countries. If, however, the superficial area and the population of the different countries are taken into consideration, Switzerland, which, in regard to the absolute length of lines and number of cars, is classed as fifth, with 17 lines, a total of 47.5 miles, and 129 motor cars, heads the list."

In the United Kingdom there are 127 miles of track and 221 motor cars, figures exceeded only by Germany and France, and seeming very small beside those of the United States, where there are no less than 16,250 miles of track now in use and about 45,000 motor cars, these being operated by 1,350 companies, and representing an investment of more than one hundred pounds sterling.

"The successful developments, both electrically and mechanically, in the United States have commenced to encourage other countries to follow American practice. As a compensation for delay, it may, however, be considered that the conservative tendency of the managers of European tramways have prevented their rushing into electric traction until such time as the untried methods have been proved successful, both practically and commercially; but now that the experimental tests of the past ten years have given unquestionably successful results, and are considered to be the standard for the construction of tramways and light railways, Europe is energetically substituting electricity for horse and steam power, and legislative restrictions are being modified to encourage the employment of capital to furnish better means of transportation to the travelling public."

The rate of progress in England may be gathered from the fact that there are now under construction nineteen electric tramways, the permanent way of which comprises about 277 miles of track, and also five important electric railways, now open or under construction, having a total track-mileage of 38.

"Progress has not been so rapid as to draw great attention to the work which British firms have already done, but, as pioneers, they are entitled to much credit for results accomplished under very adverse conditions. They have courageously stood by the ship when underwriters looked askance at the strange craft; and, now that it has got into smoother water, they may justly claim some consideration for their efforts."

Water-Tube Boilers in the British Navy.

ALTHOUGH water-tube boilers have been successfully used in the smaller vessels of the navy for a number of years, especially in torpedo boats and destroyers, there has been a decided hesitancy about substituting boilers of this type for the well-tried cylindrical or Scotch boiler for large ships; and the installation of Belleville boilers in the Powerful and Terrible was not made without strong protest and some misgivings. It was this uncertainty as to the suitability of large water-tube boilers in general which led to the selection of the Belleville boiler rather than some English design, the experience with the Belleville boilers in numerous large vessels of the Messageries Maritimes since 1885 being considered sufficient to outweigh the objections.

The Powerful has now made a cruise

from Portsmouth to Hongkong, the result of which has been to evoke much criticism of the performance of her machinery, owing mainly to the large coal-consumption; and the opponents of water-tube boilers have naturally taken the opportunity of saying "I told you so."

In an editorial discussing this matter, *The Engineer* shows that much of the criticism is the result of insufficient information as to the conditions of the cruise, and especially demonstrates that the low economy was due to other causes than the performance of the boilers. Briefly, the fact is that the Powerful, on her voyage to China, consumed 8,300 tons of coal, and that, making due allowance for the steam used in the auxiliaries, the main engines must have required more than 2.75 pounds of coal per h. p. per hour.

As the *Engineer* points out, however, the rate at which the voyage was made required only about 3,000 h. p. to be developed by engines intended to exert 25,000 h. p. and, thus working at about one-eighth of her full power, it is strange that she did not require 4 pounds of coal instead of less than 3 pounds. There were some minor casualties in connection with the engines; some bearings got hot, one pump broke, and some similar mishaps occurred, but the only difficulty which occurred to the boilers was the discovery, in two of the down-take tubes, of sufficient corrosion to require their renewal.

The cruiser Diadem, which is also equipped with Belleville boilers, has just undergone her trials, and from the discussion at the meeting of the Institution of Naval Architects it appears that, when working at about 75 per cent. of the maximum power, the coal-consumption during a twenty-four-hour run was but 1.59 pounds per i. h. p. per hour; so that there could have been nothing radically defective about the boilers in that case, at least.

The weak point of the Belleville boiler is its defective circulation, as is clearly shown by Mr. Gretchin's paper before the Institution of Engineers and Shipbuilders in Scotland upon the performance of the Belleville boilers in the Russian steamer Kherson. An illustration of these boilers will be found on page 433, Vol. XIV., No. 3, of this magazine, and from the construction it will readily be seen that the steam from the lower tubes must work its way up through the entire series above it before it can find its way into the main drum. In the case of the Kherson, this circulation at times became so feeble that the lower tubes were seriously overheated and sagged to an extent sufficient to produce leaks and give trouble. This, however, should not be taken as a characteristic of water-tube boilers in general, as in many other forms the circulation is all that can be desired.

There is no doubt that the water-tube boiler, in some form, will hereafter be the general type in the navy for all sizes. This is clearly the opinion of Mr. Goschen, who, in his remarks in the house of commons in connection with the criticisms of the trip of the Powerful, maintained that much of the trouble was due to inexperience on the part of the engineers and stokers.

Much better results will be obtained when the men have become trained to the proper use of the machinery. In the case of the Kherson it was found very difficult to get the stokers to keep the clear thin fires required by M. Belleville's rules. There is no more probability of going back to the cylindrical boilers for the navy than there is of the abandonment of breech-loading guns for muzzle loaders. Improvements will certainly be made, both in construction and in stoking, but the water-tube boiler will surely continue to be used to the exclusion of the enormous shell boilers of the present day, and increased pressures and reduced weights will follow as a natural consequence.

THE CONTINENTAL PRESS

The Properties of Nickel Steel.

BRIEF notices have appeared from time to time in the *Comptes Rendus* of the French Academy upon M. Guillaume's important researches into the physical properties of the various alloys of nickel and steel, but the complete details of these investigations have not been made public until recently.

A paper by M. Guillaume in the *Bulletin de la Société d'Encouragement* now describes the apparatus and methods used by him, and also gives the results of his researches more completely than they have been given heretofore.

While it is impossible, in the limited space here available, to examine the work of M. Guillaume at length, the peculiar properties which he has discovered possess sufficient importance to demand a brief indication, and may render the application of the alloys important for engineering purposes in different lines from those previously considered.

The principal object in view, in making these researches, was the discovery of the best alloy for metrological purposes, and the investigations covered the density, elasticity, magnetic properties, and behaviour under the action of heat. They were not intended to cover the entire magnetic properties of the various alloys, but only to use these as guides to the selection of suitable proportions for further investigation. These tests showed that alloys containing from 0 to 25 per cent. of nickel are irreversible,—that is, they possess two different sets of magnetic properties, according to the direction of the preceding temperature-changes, whether ascending or descending. For alloys containing 25 to 50 per cent. of nickel, on the contrary, the magnetic properties are reversible, depending at each temperature upon the temperature only, regardless of the preceding condition.

A similar condition of reversibility, or irreversibility, appeared in connection with changes of volume, the irreversible alloys showing, within certain limits, absolutely different changes when subjected to ascending and descending temperatures. The reversible alloys expanded and contracted in the same manner, whether cooled or warmed, but seemed to follow laws altogether different from those governing other metals or alloys.

The peculiar behaviour of the irreversible alloys can be shown only by a diagram, but the expansion and contraction of the reversible alloys is tabulated in a very interesting manner. The formula for the coefficient of expansion is given in the shape of a constant plus a function of the temperature, but neither the constant or the coefficient remains the same for different alloys. As the proportion of nickel is increased, the coefficient of expansion diminishes until the minimum is reached for the alloy containing 35.6 per cent, of nickel, after which it again increases. At this minimum proportion the expansibility is only one-tenth that of platinum, and less than one-twentieth that of brass.

The great value of this alloy for standard measures of length will be seen at once, especially as it possesses other desirable qualities. The alloy is particularly homogeneous, takes a brilliant polish, remarkably free from flaws, and has a density of about 8 and a modulus of elasticity of about 20,000,000 pounds per square inch.

In order to attain the best results, the bar of this alloy is subjected to a prolonged elevation of temperature, lasting for several days, after which the molecules appear to have arranged themselves in the most stable position, so that the subsequent changes of length for differences of temperature are reduced to a minimum. The influence of this reheating also renders the small, but ordinarily somewhat variable, expansion coefficient practically constant. If it is desired to secure a variation of less than 0.001 millimeter in a

length of one meter, the bar should be maintained at a temperature of boiling water for 80 to 100 hours. A still greater degree of precision may be obtained by giving the bar a series of prolonged heatings for several hundred hours at successively diminishing temperatures; in this way bars for the measurement of geodetic base lines may be obtained with the temperature error practically eliminated.

A variation of 1 mikron per meter in the length of a pendulum corresponds to less than 0.05 second per day; in fact, a clock with a pendulum rod of this alloy has shown a rate of less than 0.02 second per day for a period of six months.

Although the researches of M. Guillaume are not yet completed, the facts which he has made public are of much value, and his full account of his work will be found both interesting and practical.

Compound Locomotives.

FOR several years past the Northern Railway of France has been endeavoring to improve its express service, and the result is the introduction of an improved form of compound express locomotive, of which a full account is give in *La Revue Technique.*

The engine is a four-cylinder compound, the low-pressure cylinders being placed inside the frames and coupling to the forward cranked axle. The high-pressure cylinders are outside, and connect to the rear driving axle, but have also parallel rods to connect both axles, although, from the experience of Mr. Webb on the London & Northwestern, it seems as if the parallel rods might be omitted. Doubtless this coupling of the axles has been done, in order to give better starting adhesion, this having always been a weak point with single drivers. A starting valve permits high-pressure steam to be used in all four cylinders, if necessary, although in this case the cylinder power will exceed the adhesion, unless the rails are well sanded.

The total weight of the engine is 50 metric tons, of which 31 tons are on the driving-wheels, and the cylinders are 13.4 inches and 20.9 inches in diameter respectively, and 25.2 inches in stroke, fitted with Walschaert valve gear.

Especial attention has been given to the boiler capacity, the intention being to have a sufficient power in reserve to enable the maximum effort to be exerted whenever necessary, without drawing down the pressure appreciably, and to enable power to be stored when the demand is slight, and held for future use. The total capacity of the boiler is 215 cubic feet, of which 142 is water capacity and 73 is steam space, there being 1,890 square feet of heating surface and 25 square feet of grate surface. The firebox is of the Belpaire type, and, as is customary in Europe, is made of copper, copper staybolts being used with holes in them to indicate by leakage the fact that a break has occurred.

These engines have only recently been installed, and no records of their speed are yet given out, although there is every reason to believe that they will enable the present express speed of the road—120 kilometers, or about 75 miles, per hour—to be surpassed.

Originally three engines were designed by M. Glehn, of the *Société Alsacienne de Constructions Mécaniques*, and the operation of these was sufficiently satisfactory to result in an order for twenty additional locomotives of similar construction.

Doubtless further reports will be made of the performance of these engines, and, in point of speed and of fuel-economy, they should give good account of themselves.

Radial Valve Gears.

ALTHOUGH the link motion successfully holds its own as a practical reversing valve gear for locomotive engines, with only a partial competition from the Walschaert single-eccentric cross-head combination in Belgium and Switzerland, other forms have been found more acceptable in many instances for marine use, especially the modifications of the so-called "radial" valve gear of Hackworth.

A general study of these radial gears, under the name of "single-eccentric valve gears," is given in a paper by Herr von

Berling, of the Imperial shipyard at Kiel, in the *Zeitschr. des Vereines deutscher Ingenieure*, with many comparative diagrams, enabling an excellent view of the various modifications to be obtained.

One of the principal advantages of the radial type of gear for marine engines is the fact that the natural construction brings the valve connection out at the side of the engine, whereas in the case of the link motion it is directly over the shaft.

This is especially convenient for multiple-expansion engines, since it enables the valve chests to be on the side of the cylinders instead of between them, making the parts much more accessible and permitting the engines to be more compactly designed. With the radial gears there are also certain advantages in steam distribution over that given by the link motion with two eccentrics, and some undesirable features in construction are avoided.

The general principle of all the radial valve gears consists in the use of a single eccentric, or even the main crank itself, through connection with the proper point on the connecting rod, in combination with some simple form of slide block or radius arm to provide for the proper angular advance and to permit of reversal. In the case of a vertical engine, for example, the eccentric, being set either in line with, or directly opposite, the crank, furnishes by the vertical component of its travel the necessary movement of the valve up to the port opening, while the opening and closing of the port are effected by some transformation of the horizontal component.

The original gear of Hackworth used a slide block, moving in an adjustable guide, the position of this guide determining the opening and closing of the ports and also the direction of the motion of the engine; and the gears bearing the names of Klug, Marshall, and Bremme are only modifications in detail of this fundamental form. The Joy valve gear, which has been applied both to locomotives and to marine engines, differs mainly in the substitution of a point on the connecting rod for the eccentric, there being therefore no eccentric used with this gear, although its equivalent in motion is obtained. Klug and Bremme both have used radius arms in place of slide bars, and a variety of minor modifications have been made in all these main forms to meet special requirements.

Herr Berling gives a general analysis of the radial valve gear, using the Zeuner polar diagram, and shows by valve ellipses the variations in distribution which result from changes in proportions and arrangement; the applicability of the Reuleaux diagram is also shown.

In view of the increasing use of radial valve motions, especially for marine use, and also the limited amount of accurate information available outside of the designing rooms of great shipbuilding establishments, this contribution from the great shipyards at Kiel is to be welcomed, and will doubtless be made of use by many engineers and designers in marine work.

Fly-Wheel Explosions.

ALTHOUGH there have been numerous explosions, or rather burstings, of fly-wheels in various countries, especially since the general increase in rotative speeds in stationary-engine practice, the usual rules for the proportioning of this important part of an engine give little or no attention to the magnitude or direction of the stresses induced by centrifugal force. In some recent instances wheels have been made with wire-wound rims, or with built-up rims of wood, but most of the work in this direction has been empirical rather than precise or scientific.

For this reason the paper upon the direction and magnitude of the stresses in fly-wheel rims and arms which has appeared in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, by Herr J. Goebel, is a welcome contribution to the subject of steam-engine proportions. The paper was called forth by the fact that a fly-wheel in a rolling mill near Cologne burst under conditions which showed that the accepted theory, due to Grashof, could not be correct, even when the influence of possible shock was taken into account. A number of investigations of other and

similar disasters were then made, and upon the results of these researches the paper is based.

According to the general theory, the stress induced in the rim of a fly-wheel by centrifugal force is similar to that produced in the shell of a boiler by internal pressure, and tends to cause a circumferential strain in the metal of the rim. Such stresses can easily be computed, being dependent only upon the diameter of the wheel and the number of revolutions, and, for any given speed-and-stress limit, the maximum diameter permissible is readily found.

In actual practice, however, the rim is not a free ring, but is restrained by the arms from assuming an enlarged circular shape under increased stress. Instead, there is a bending action in the segments of the rim between the arms, together with a longitudinal pull upon the arms themselves, while, if there is any acceleration or retardation of speed, there will be also a bending action on the arms, and a shifting of the points of greatest stress in the rim segments.

These various forces are taken up by Herr Goebel successively, the treatment being mathematical in its nature, but entirely applicable to practical use. In every instance the stresses due to each action may be computed separately, and it can then be seen which is the greatest, and the proportions can be made to correspond.

Another point demanding especial attention is the manner of securing the various parts of the wheel together; it is shown how fastenings amply strong in themselves may be so applied as to oppose only a portion of their strength to the stresses in the wheel. In the case of the wheel which burst at Cologne it is shown that the improper arrangement of rim connections was probably the cause of the original fracture, after which the other portions were, of course, destroyed.

The whole paper is an excellent study in itself, and the formulas will be found useful in future investigations of a form of breakdown which has become altogether too frequent of late.

The Utilization of Glacier Ice.

UNTIL recently the principal commercial value of the Alpine glaciers has been considered to lie in the attraction which they have offered to tourists, and the consequent revenue which has accrued to the skilful exploiters of natural scenery.

During the past year, however, a more practical idea has been developed, and the glacier du Casset, near Briançon, is now regularly operated as an ice quarry, the blocks being cut and conveyed over an overhead cableway to a convenient place for shipment by rail to Paris, there to be consumed in the cafés and hotels of the metropolis.

A fully-illustrated account of this curious industry is given in *Le Génie Civil*, with photographic views of the glacier and details of the methods employed.

A moderate clearing of the face of the glacier revealed a vertical front of ice 25 to 30 feet in height and about 100 feet in clear width, and from this quarry the ice is removed in blocks in the following manner. Vertical grooves 6 feet deep and about 8 feet apart are cut in the wall of ice, extending from the base to the top, and a similar channel is cut from the top downward behind the ice, the rear cut extending only about one-third of the way down. A small excavation is then made under the foot of one of the rectangular pillars, and a light blast of powder is sufficient to bring down the mass, usually in three or four large pieces.

These large blocks are further broken into pieces from 200 to 300 pounds in weight, and passed down slides to the loading platform of the cableway. The larger pieces are caught in grappling tongs, and the smaller ones packed in boxes, these being suspended from the trolleys. The ice is thus sent down the mountain side a distance of nearly a mile and a half, the difference in elevation between the two ends of the cableway being about 1,300 feet.

As the loads are always on the descending side of the endless cable, no other source of motive power is necessary than the weight of the ice itself, and a controlling brake device is used to prevent an

undue acceleration from taking place. At the lower platform the ice is unloaded from the trolleys into carts, and hauled to the railway station at Briançon, about ten miles distant, where it is shipped to Paris.

The cost of installation of the cableway, including the construction of the wooden supports and all details ready for operation, is given as 25,000 francs, and the daily cost of operation of the entire plant, employing about 30 men, is 150 francs. As the output is about 100 tons of ice per day, the cost is but 1.50 francs per ton, at the lower platform of the cableway. The cost of hauling to Briançon is about 6 francs per ton, and, including the wastage by melting in the summer time, the cost of glacier ice at the Briançon station is about 9 francs per ton.

As this interesting plant has been in succesful operation since July of last year, there seems to be no doubt of its mechanical success, while its value as a commercial investment will probably depend somewhat upon the season, and upon the scarcity of ice from other and former sources.

Steel Cross-Ties.

THE use of metallic ties for railways is generally limited to warm countries, in which wooden ties, because of their short life, are more expensive in the end than the higher-priced ties of steel.

In south Africa it is practically impossible to use wooden ties since the ravages of the white ants soon destroy the wood. Steel ties are much used in Turkey, and a recent issue of *Le Génie Civil* gives an interesting account of the method of constructing the railway in Anatolia, including the special appliances which the use of metallic ties makes possible.

The ties used are of a mild steel, pressed into a channel shape, with the ends bent somewhat downward, and the rails are attached by bolts and cleats in such a manner as to form complete sections which can be handled as units. This does not permit of the placing of the joint between one pair opposite the middle of the rail on the other side; so the joints are placed opposite each other. The rail used is about 32 feet long, and weighs 60 pounds per yard, 11 cross-ties being used to a length, and placed about 30 inches apart.

The sections thus prepared, when they are to be sent out on a construction train, are piled in the yard and loaded upon flat top cars by a travelling gantry crane. The engine by which this construction train is hauled is a curious affair; it carries a pair of cantilever trusses extending back over the car behind, and forward over the roadbed in front, being inclined toward the front. On this cantilever is a trolley crab, which can be run back over the car behind, and, picking up a complete section of track, carry it entirely over the locomotive and deliver it in position in front of the train. The locomotive is built with especial reference to the operations of this cantilever device, the smoke-stack being on one side.

The track sections are not piled directly upon the cars, but are upon small trucks resting on rails running the whole length of the train, so that, when the car next behind the cantilever is emptied, the load upon the next one behind can be run forward bodily, and thus the whole train of material can be delivered, the train being moved forward upon the newly-laid tracks.

As an example of the work which has been done in this manner, it is stated that on a section of straight road 3,132 yards, or about 1¾ miles, was laid in 13 hours, while, of course, a slightly slower rate was obtained on curved portions of the way.

Another example of the use of metallic ties is found on some portions of the St. Gothard railway, where they were originally introduced on the more difficult sections, it being feared that the strength of wooden ties would be insufficient. Some of these have been in use for more than ten years, and a recent report gives information as to their durability and serviceableness.

So far as durability is concerned, the results have been very satisfactory, except in the tunnels, where the dampness causes rusting; but even under these conditions the life of the steel sleepers equals that of wood, while on other portions of the road

the tendency to rust is very slight, and there is every reason to believe that the ties will last as long as the rails themselves.

Although the cost of the steel ties is more than 20 per cent. greater than that of the oak ties used in Switzerland, in the long run the metallic ties are found to be decidedly cheaper, not only because of their greater durability, but also because of their greater value as old material when their usefulness as ties is past.

Experiments with Diverging Nozzles.

IN the construction of jet apparatus of any kind it is well known that the flow through a nozzle is greatly affected by the shape and character of the nozzle itself. Many experiments have been made, both with liquids and gases, to determine the actual behavior of the flowing material, and the latest contribution to this branch of mechanical physics is a study of the flow of air through diverging nozzles, made by Professor Fliegner and published in a series of articles in the *Schweizerische Bauzeitung*.

The diverging nozzle forms an important feature in the steam turbine of de Laval, and it was to investigate the action of such discharge-tubes that the experiments were undertaken. The work was done in the mechanical laboratory of the Zurich Polytechnic, where excellent facilities for such investigations are to be had.

The compressed air was drawn from a tank supplied by a compressing pump driven by a hydraulic motor, and the conditions of operation were kept well under control.

Two nozzles were used, both of the same length,—*i. e.*, 10 centimeters,—and both 5.17 mm. bore at the smallest part, the difference being in the angle of the diverging discharge portion. At three points in the side of the nozzle small apertures were made for the purpose of measuring the pressures, one opening being in the short cylindrical commencement of the tube, another near the outer end, and the third at the middle point.

Great care was found necessary in order to obtain the true pressure existing at any given point in the nozzle, as discordant results were found if the stream was tapped, so to speak, either in the axis or at the outer portion, the indications being too low in the former case, and too high in the latter. A small tube was therefore inserted in the gauge hole, and adjusted so as to give the most uniform results. For this purpose Professor Fliegner found the needle of a hypodermic syringe to be the best form of connection, consisting as it does of a steel tube of fine bore with the end bevelled off in a manner well adapted to divert the air from the main jet into the gauge.

Many experiments were made upon nozzles with different angles and air at various pressures, and the results were plotted in diagrams to furnish data for the construction of curves to enable the fundamental laws to be deduced. There are a number of these diagrams in Professor Fliegner's papers, and to them the specialist must be referred, but the general conclusions may be here stated.

When the angle of divergence is small, the pressure in all portions of the jet is greater than that of the atmosphere. When, however, the angle exceeds 1°, under certain conditions a suction may exist. This curious action is shown by bringing a horizontal gas flame over the edge of the vertically-discharging air nozzle, when it will be seen that the flame is drawn down into the edge of the nozzle, from which a strong discharge of air is issuing, although the flame is at several millimeters, distance.

The tabulated results of the experiments also show that, while for cylindrical tubes the velocity continually diminishes, it remains practically uniform for the diverging nozzle. The ratio which the pressure in the tube bears to the atmospheric pressure also appears to have an important influence upon the distribution of pressure in the nozzle, and, when this ratio is less than 0.5, the pressure diminishes regularly throughout the nozzle in proportion to the increasing volume, but, when the ratio is greater than 0.5, a compression appears, instead of a reduction in pressure.

It was some of these results which led

Professor Fliegner to question the conclusions of de Laval in connection with the nozzles of the steam turbine, and to suspect that pressures measured at the periphery of the jet had been taken to represent the mean pressure of the whole section. The carefully tabulated and plotted results of these important experiments bear directly upon the proportioning of jets for this and similar purposes, and the publication of these results should be the means of saving much difficult and tedious experimental research in the future.

The Society of Civil Engineers of France.

THE celebration of the fiftieth anniversary of the existence of the Society of Civil Engineers of France, of which an outline is given in the *Moniteur Industriel*, recalls some points of interest in connection with the career and work of the organization.

The actual date of the anniversary was March 4 of this year, at which time an official meeting was held, but a more general celebration has been arranged for June 10-13 inclusive, at which time a full account of the history of the organization will be given, in public and official form.

The society was founded almost immediately after the revolution of February, 1848, by a group of former pupils of the Ecole Centrale, who believed that the time had come for the civil engineers of France to found an organization to advance their interests as corresponding interests had been advanced in England since 1818 by the Institution of Civil Engineers. The names of the original founders are worthy of record: MM. Alcan, Ch. Callon, Faure, Laurens, and Thomas; while among the early additions to the list may be mentioned MM. Bricogne, Polonceau, Yvon-Villarceau, and many others.

Although the first meeting was held in March, it was not until July 13 that the constitution was definitely adopted; hence the selection of this latter date for the celebration. At the end of the first year the membership numbered 135, the present membership being more than 2,700.

The greatest advances of the society, both in membership and in influence, have been in connection with the International Expositions, which have been so directly connected with the work of the engineer as to be necessarily bound up with it, and a comparison of the growth of the society with the dates of the expositions will reveal the relation very clearly.

Not the least important work of the society is found in its official publications, of which there are the Bulletins and the Annuals. The Bulletins, which originally appeared only quarterly, have been issued monthly since 1880, and contain the records of the meetings, text of papers read, and abstracts of proceedings of other foreign societies bearing upon the general science of engineering, while these are subsequently collected into the bound volumes, of which 65 have appeared, containing about 800 original papers upon questions of value and importance relating to the profession of civil engineering.

A number of prizes have been founded by the society, representing an annual value of more than 80,000 francs, among which may be mentioned the annual prize of the gold medal of the society for the best paper of the year; the Nozo prize, awarded every three years, for the best engineering work executed during that period; and the Giffard prize, awarded triennially for the best discussion of a given subject.

Besides awarding prizes to others, the society has itself been the recipient of numerous honors. Among these are cited: the brevet of the government for services rendered in the national defence in the war of 1870-71; the Diploma of Honor of the exposition of 1878, and the Grand Prize at the exposition of 1889; the Diploma of Honor of the Antwerp exposition of 1894; the Grand Prize of the Bordeaux exposition of 1895; also a special medal and diploma from the French government for its work at the World's Fair at Chicago in 1893; and the highest award at the Brussels exposition of 1897.

In thus noting the growth and success of one of the great national engineering societies, it may not be amiss to note that it is by means of just such organizations

that the barriers of national prejudice are broken down. There is no wider republic than the republic of science, and, while engineers of all countries are true to their own countries in all that relates to strictly national affairs, they are also the broadest of cosmopolitans in all other respects. The great expositions have again and again been occasions for reunions of engineers of many nations, and in every case the love of science and the appreciation of the work of fellow-engineers of all lands has been found strong in its influence for international brotherhood. It has been so in the past, and already it is becoming apparent in connection with the coming exposition, in which, as in those which have gone before, the work of the engineer is of commanding importance and influence.

Modern Arch Construction.

AN interesting example of bridge replacement, enabling old and new work to be well compared, is found in the case of the construction of the new stone arch bridge over the Ill at Feldkirch in the Vorarlberg, Austria, of which an excellent general and technical account is given in the *Oesterr. Monatschrift für den öffent. Baudienst.*

The river at Feldkirch passes between rocky banks, affording excellent opportunity for good foundations, and ever since the middle of the thirteenth century it has been spanned by a single arch stone bridge. In old times this bridge was most important, as it formed part of the high road over which a great part of the travel passed between Italy and southern Germany, and it has always been carefully preserved and cherished under the name of the Bridge of the Holy Cross (*Heiligkreuzbrücke*).

The form of the old bridge was a semicircular stone arch, the builders of six hundred years ago hardly daring to cope with the thrusts produced by flatter curves. In order to obtain the rise necessary for the span of 60 feet, the roadway was graded up on each approach, forming steep ascents. The narrowness of the road—only 11 feet between parapets—made the use of the bridge very limited.

Historical associations have caused the replacement of this old work to be deferred again and again, and repairs and restorations have kept it together and in fairly serviceable condition; but finally it has been taken down and replaced by a segmental stone arch of modern design, which does not detract from the picturesque surroundings, but does afford satisfactory communication between the two banks of the stream.

Since the depth of the gorge afforded sufficient room for the highest water in the river, it was decided to lower the bridge enough to avoid the steep ascents at the approaches, and the new arch has a rise of only 15.6 feet for a span of 62.3 feet, or practically one-fourth of the span. Since the springings of the new bridge are nearly five feet higher than those of the old arch, there is a lowering of the roadway of about 10 feet, and the approaches are rendered very easy.

The computations for the new arch were made by the graphical method, both for uniform and variable loading, and the strain diagrams are given in the account of the work, the whole forming an excellent practical example of the modern method of arch design. The distribution of the statical load is so well effected that the line of pressure is scarcely diverted from the middle of the arch ring when one-half the arch is subjected to its maximum loading, and the increasing thickness of the ring from the key to the abutments provides for the increasing pressure.

The work of erection also involved the removal of the old arch, which was accomplished by first placing a wooden centring beneath, thus enabling the old work to be removed piecemeal. It was interesting to observe the manner in which six hundred years of exposure had affected the masonry; it appeared that the action of frost and weather had been only superficial, and that the inner work was in fairly good condition.

The work, while not of great magnitude, affords an excellent study of modern and mediæval arch construction.

THE ENGINEERING INDEX

INTRODUCTORY

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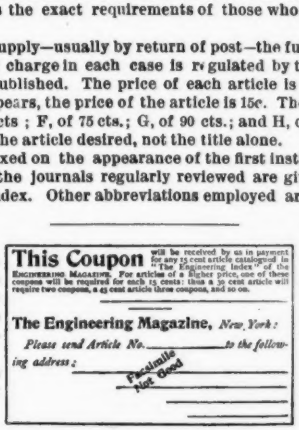
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American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
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Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
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New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Alterations.

Alteration Work in Occupied Buildings. Illustrates the reconstruction of a front wall of sixth story of a Chicago building. 1000 w. Eng Rec—April 2, 1898. No. 19415.

Amphitheatre.

The Rapid Construction of Amphitheatres. (Construction Rapide d'Amphitheatres.) A discussion of the rapid construction of large stands of the amphitheatre form for enabling a great number of spectators to witness reviews and similar public spectacles. Data concerning the examples at Mirecourt and at Chalons are given. 1500 w. La Revue Technique—April 10, 1898. No. 19820 D.

Baths.

Public Baths at Pirna on the Elbe. (Volksbad in Pirna a. d. Elbe.) Description, plan and elevation of convenient new bath building of moderate cost. 1000 w. Deutsche Bauzeitung—March 23, 1898. No. 19857 B.

The Municipal Public Baths in Vienna. (Die Städtischen Volksbäder in Wien.) H. Bernaneck. With plans of the buildings, and data and tables showing the operation and extent to which the baths are used. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—March 25, April 1, 1898. No. 19843 each B.

See also Plumbing.

Cloister.

The Cloister of St. Jerome at Belem, Portugal. (Das Kloster Dos Jeronymos in Belem, Portugal.) A description of the beautiful Romanesque cloisters belonging to the cathedral of Belem, near Lisbon, with illustrations. 2500 w. Wiener Bauindustrie Zeitung—March 24, 1898. No. 19878 B.

Domes.

The Metal Dome of the City-Hall Tower, Philadelphia, Pa. Francis Schumann. An abstract of the official report of the writer upon the construction of the dome, giving interesting details. Ill. 12000 w. Pro of Engs Club of Phila—March, 1898. No. 19445 D.

Erecting.

A Traveling Building Erection Tower. Illustrates a tower derrick with special features, used on many high buildings in New York. 800 w. Eng Rec—April 23, 1898. No. 19729.

Fireproofing.

Experts' Report on the Pittsburg Fire. Reviews a report of Corydon T. Purdy on the conclusion of the Board of Experts appointed by fire underwriters to study the Pittsburg fire of May 3, 1897. 3500 w. Eng Rec—April 23, 1898. No. 19730.

Holland Tile Fireproofing in the Park Row Syndicate Building. Reviews the contest between manufacturers and the Board of Examiners of New York in regard to the flooring of the 30-story Park Row Syndicate Building. Illustrations of the defective work in hollow-tile flooring. 1000 w. Eng News—April 14, 1898. No. 19594.

How to Build Fire-Proof. Francis C. Moore. A summary of important points discussed in a series of articles on this subject. 6200 w. Br Build—April, 1898. No. 19759 C.

Foundations.

Steel Foundations of Buildings and Electrolysis. Statements of General Sooysmith and Mr. Geraldine, as published in the Chicago *Tribune*, calling attention to this danger, and claiming unmistakable evidence that the action of electrolysis has begun. 1000 w. Elec, N. Y. —April 20, 1898. No. 19687.

Grain Elevator.

The Steel Tank Grain Elevator "Great Northern" at Buffalo, N. Y. Illustrated description of the structural features, storage bins, operating machinery, &c. 3800 w. Eng News—April 7, 1898. No. 19457.

Hospital.

The Alland Hospital near Baden, Austria. (Die Heilanstalt Alland bei Baden.) Elevation and plans of this fine new hospital especially intended for patients affected with pulmonary diseases. The sanitary and disinfecting arrangements are fully described. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 18, 1898. No. 19841 B.

Hotels.

The Grand Hotel Royal at Budapest. (Grand Hotel Royal am Elizabethring in Budapest.) An illustrated description of the largest and handsomest hotel in Budapest, with floor plans, elevation and section. 1000 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19847 D.

The Hotel Waldorf-Astoria, New York. W. G. Mitchell. A criticism of the design, with plans and illustration of one bedroom. 1700 w. Am Arch—April 2, 1898. No. 19402.

Library.

Tne New University Library at Basle. (Die Neue Universitäts Bibliothek in Basel.) Elevation, plans and details of book stack of this new university library. 1200 w. Deutsche Bauzeitung—March 26, 1898. No. 19858 B.

Mortuary.

The New Mortuary Building at Munich. (Le Nouveau Monument Mortuaire à Munich.) A. Dutreux. Photographic views and plans of the fine mortuary building recently erected at the eastern cemetery at Munich, Bavaria. 1000 w. 1 plate. Le Génie Civil—April 9, 1898. No. 19811 D.

Palace.

The Palace of Herrenchiemsee, and its Ornaments and Decorations. (Schloss Herrenchiemsee, seine Decorative Ornamentik und Figurale Plastik.) A descriptive account of this show palace of Bavaria, with several views of the interior decorations. 2500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19846 D.

Parliament Buildings.

The Parliament Buildings in Budapest, Compared with other Parliament Buildings. (Das Parlamentsgebäude in Budapest in Parallele mit anderen Parlamentsbauten.) August Prokop. A valuable comparative discussion of many of the legislative buildings of Europe with ground plans and photographic views. Two articles. 5000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—April 1, 8, 1898. No. 19844 each B.

Permanence.

Ephemeral Construction. Editorial on the evidence of real permanence in construction being sought in architectural work, and of great activity in this field. 1200 w. Br Build—April, 1898. No. 19758 C.

Post Office.

The Enlargement of the Imperial Post Office, Berlin. (Der Erweiterungsbau des Reichspostamtes.) With effective illustrations of this important public building. Two articles. 2500 w. 1 plate. Deutsche Bauzeitung—April 2, 9, 1898. No. 19859 each B.

Renaissance.

The Methods of the Masters of the Italian Renaissance. (Die Arbeitsweise bei den Meistern der Italienischen Renaissancezeit.) An address delivered before the Society of Architects at Berlin, March 13, 1898, by City Architect, Ludwig Hoffmann. Two articles, 3000 w. Schweizerische Bauzeitung—April 2, 9, 1898. No. 19836 each B.

Steel Construction.

American and English Practice in Architectural Steel Construction. Charles V. Childs. A comparison, with illustrations, of the different methods of construction existing in the two countries. 2500 w. Engineering Magazine—May, 1898. No. 19937 B.

The Spreckels Building, San Francisco. A 19-story steel-cage structure which withstood the earthquake of March 30, 1898, without injury. Gives illustrations of foundations and details of steel framework. 1600 w. Eng Rec—April 9, 1898. Serial. 1st part. No. 19475.

Towers.

Towers and Spires. George H. Blagrove. Part first deals with the foundations of towers. 2000 w. Ill Car & Build—April 8, 1898. Serial. 1st part. No. 19640 A.

HEATING AND VENTILATION.

Heaters.

Instantaneous Water Heaters. Thomas D. Miller. Read at meeting of the Texas Gas and Electric Light Assn. Presenting the advantages of this appliance, with account of its construction and working. Also discussion. 3800 w. Am Gas Lgt Jour—April 18, 1898. No. 19637.

Hotel.

Steam Plant of the Astoria Hotel. Illustrated description of the 25,000 h. p. steam plant for heating and power purposes. 1800 w. Eng Rec—April 16, 1898. No. 19627.

Minneapolis Building.

Heating and Ventilation of the Wyman-Partridge Building, Minneapolis, Minn. Illustrated detailed description. 1200 w. Heat & Ven—April 15, 1898. No. 19739.

Piping.

Systems of Piping in Steam Heating. William Mansell. Read before the Toronto Chapter of Architects. Recounts some of the improvements and the general progress in this field. 2700 w. Can Arch—April, 1898. No. 19717 B.

Radiators.

Concerning Ribbed Heating Tubes. (Ueber Rippenheizkörper.) A discussion of the best proportions for ribbed or "extended" radiating surfaces to obtain the greatest amount of heat from the steam or hot water within. 1200 w. Gesundheits-Ingenieur—March 31, 1898. No. 19863 B.

Residence.

Heating a Country House. Describes the system in use at the residence of W. S. Opdyke, at Alpine, N. J. It is a combination of direct and indirect steam heating, a part of which is piped on the single-pipe system and a part on the two-pipe system. 1800 w. Met Work—April 2, 1898. No. 19352.

Testing.

A Preliminary Study of a Method of Testing Carbonic Oxid in the Atmosphere. (Etude préliminaire d'une Méthode de Dosage de l'Oxyde de Carbone Dilué d'Air.) A. Gautier. A contribution to the French Academy giving tests of very small quantities of carbonic oxid by the use of iodic anhydride. The reaction is shown to take place when the carbonic oxid is diluted with 30,000 times its volume of air. 2500 w. Comptes Rendus—March 28, 1898. No. 19822 D.

PLUMBING AND GASFITTING.

Bath.

A Pittsburg Bath House. Illustrates a public bath with 22 rain baths and other less important fixtures. 700 w. Eng Rec—April 9, 1898. No. 19476.

See also Construction and Design.

Canada.

Plumbing Regulations in Canada. A copy of the regulations submitted by the sanitary committee of the Nat. Assn. of Master Plumbers of Canada. 3000 w. Dom Engng—April, 1898. No. 19616 C.

Hospital.

Plumbing in Lavatory Towers. Illustrates towers built against outside walls of an old hospital in New York, to furnish adequate lavatory facilities and ventilation. 1200 w. Eng Rec—April 23, 1898. No. 19731.

Ordinance.

Rock Island (Ill.) Plumbing Ordinance. An ordinance recently passed by the city council. 5000 w. San Plumb—April 15, 1898. No. 19777.

Stables.

Stable Plumbing. Illustrated description of the plumbing in the stable of M. F. L. Hungerford, New Britain, Conn. 1300 w. Met Work—April 16, 1898. No. 19612.

MISCELLANY.

Accounts.

Some Old Italian Building Accounts. William Scott. Some accounts of two or three centuries ago, giving an insight into methods used, cost of labor, materials, &c. 1300 w. Jour Roy Inst of Brit Archs—March 12, 1898. Serial. 1st part. No. 19504 B.

Casa Grande.

Repair of the Casa Grande Ruin, Arizona. Description with illustration of this work of aboriginal house-builders, for the preservation of which the U. S. Congress has appropriated a sum of money. 1800 w. Am Arch—April 23, 1898. No. 19733.

Chimneys.

Restoring the Verticality of Two Colliery Chimneys. M. Perrin. From a communication to the Société de l'Industrie Minérale. The work is described and its cost given. Ill. 1300 w. Col Guard—April 1, 1898. No. 19534 A.

Civic Architecture.

Civic Architecture from its Constructive Side. Charles Rollinson Lamb. The architectural development of New York, with suggestions and illustrations from numerous cities. Ill. 10000 w. Munic Af—March, 1898. No. 19556 C.

Columns.

A Straight Line Formula for Cast-Iron Columns. Samuel Osgood Miller. Gives diagram made from data obtained in tests made at Phœnixville, Pa., and Watertown, Mass. 900 w. Sch of Mines Quar—Jan., 1898. No. 19916 D.

Copyright.

Artistic Copyright. Georges Harmond. Read at meeting of the Roy. Inst. of Brit. Archts. Abstract of paper with editorial comment, and discussion. The protection of copyright in architectural design, as regarded on the continent of Europe. 4800 w. Builder—April 9, 1898. No. 19671 A.

Elevators.

Elevators in Private Houses. From the N. Y. *Evening Post*. The growing use of the elevator in private residences, with remarks on the design, motive power, cost, &c. 800 w. Arch & Build—April 9, 1898. No. 19477.

Gardening.

The City Garden. W. A. Langton. The importance to a building of the treatment of its site is discussed, and suggestions given. 3300 w. Can Arch—April, 1898. No. 19716 B.

Government Buildings.

Parliamentary Debate on the New Government Buildings. Reprint from the London *Times*. Deals with the expenses for new public buildings in London. Debate in the House of Commons. 4600 w. Brit Arch—March 25, 1898. No. 19378 A.

Hull, England.

The Architecture of our Large Provincial Towns. Illustrated description of the town and its architecture. 5500 w. Builder—April 2, 1898. No. 19559 A.

Inspection.

The Inspection of Buildings. Benjamin Franklin. Enumerates some points causing embarrassment in the application of the Building Inspection Law of 1893, and some of the instructive and interesting results from different methods and materials, with other information. Ill. 6000 w. Pro of Engs Club of Phila—March, 1898. No. 19446 D.

Light Rights.

Rights of Light and Other Easements. A. A. Hudsen. Read before the Society of Architects, London. On the position of owners of property with regard to light and other easements, considering the possibility and advisability of legislation. 1500 w. Arch, Lond—April 1, 1898. No. 19543 A.

Monuments.

Preservation of Historical Monuments. Gives the law in France. 2000 w. Arch, Lond—April 8, 1898. No. 19664 A.

Preservation of Historical Buildings. Gives the regulations of the provincial commissions of historical monuments in Spain, which were approved Dec. 30, 1881. 1000 w. Arch, Lond—April 15, 1898. No. 19767 A.

Preservation of Historical Monuments. Information concerning the means adopted for the preservation of antiquities in Greece. 2000 w. Arch, Lond—April 1, 1898. No. 19544 A.

Preservation of Historical Monuments. Report on the legislation in Italy for preventing the destruction of historical buildings. 4500 w. Arch, Lond—March 25, 1898. No. 19375 A.

Nails.

The Holding Power of Nails in Douglas Spruce (Oregon Pine) and in Redwood (Sequoia Sempervirens). Frank Soule. Data obtained from tests made in the laboratory of the Univ. of California, in Berkeley, and conclusions drawn. 4200 w. Jour Assn of Eng Soc—Feb., 1898. No. 19361 C.

Painting.

Mural Painting. Edwin Howland Blashfield. Discusses the requirements of mural painting, its value as an educator, &c. 4800 w. Munic Af—March, 1898. No. 19558 C.

Renaissance.

English Renaissance Architecture. Reviews a work entitled "A History of Renaissance Architecture in England, 1500-1800," by Reginald Blomfield. 4000 w. Builder—April 16, 1898. No. 19766 A.

Revival.

The Possibilities of an Eighteenth-Century Revival. Arthur T. Bolton. Discusses the character of the architecture of this period, its limitations, &c., considering dulness an almost inseparable quality. 2800 w. Jour Roy Inst of Brit Archs—March 12, 1898. No. 19503 B.

CIVIL ENGINEERING.

BRIDGES.

American Bridges.

American Bridge Shop Practice. Editorial on the progress and the credit due the manufacturers, with a summary of prevailing practice and tendencies. 2700 w. Eng News—April 21, 1898. No. 19699.

Arches.

History of the Stone Arch. Malverd A. Howe. An interesting historical account, with illustrated descriptions of many ancient and modern structures in which the arch is used. 4200 w. Jour Assn of Eng Soc—Feb., 1898. No. 19363 C.

Rebuilding the Bridge of the Holy Cross over the Ill at Feldkirch in Vorarlberg. (Neubau der Gewölbten Heiligkreuzbrücke über den Illfluss bei Feldkirch in Vorarlberg.) Theodor Pawlik. A valuable paper describing the replacement of an old semi-circular arch by a flatter segmental structure, with all details of the computation, and erection. 10000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19848 D.

The Niagara Arch Bridge Swung. Describes the predecessors of this arch, the longest truss bridge on the continent. 700 w. Eng Rec—April 23, 1898. No. 19728.

The Niagara Arch. From data and prints furnished by Fred. W. Cohen. Treats of the novel points and method of erection. Ill. 3000 w. Stevens Ind—Jan., 1898. No. 19399 D.

The Niagara Railway Arch. R. S. Buck. Gives a historical review of former bridges on the site, and description of the present bridge with fine illustrations. 6300 w. Pro of Am Soc of Civ Engs—April, 1898. No. 19779 F.

Steel Arch Highway Bridge Over Fall Creek, Ithaca, N. Y. Illustrates and describes a bridge consisting of two plate-girder arch ribs braced together by cross-frames and a triangular lateral system, and carrying vertical latticed ports which uphold the floor system. 500 w. Eng News—April 28, 1898. No. 19790.

Buckling.

The Resistance to Buckling in the Vertical Members of a Truss Subjected to Unequal Loading. (Der Knickungs-Widerstand der Wandstabe eines Gitterträgers bei Ungleichmassiger Beauspruchung.) C. J. Kriemler. A graphical and analytical solution of this important problem in statics. 2000 w. Schweizerische Bauzeitung—Feb. 26, 1898. No. 19833 B.

Cincinnati Bridge.

The Newport and Cincinnati Bridge. Illustrated description of this 3,375-ft. structure, with 510 ft. channel span, which presents some unusual details owing to unsymmetrical loading. 400 w. Eng Rec—April 23, 1898. No. 19721.

Drawbridges.

Some Features of Draw or Rotating Bridges. Editorial explanation of recent failures of turntables. 700 w. Eng Rec—April 2, 1898. No. 19407.

Foundation.

The Foundation of the Right Pier of the Kornhaus Bridge at Berne. (Kornhausbrücke in Bern. Baugeschichte des Rechtufrigen Hauptpfeilers.) P. Simons. An account of the successful manner in which the pier for the great arch has been constructed in difficult ground on a steep slope. Two articles. 4500 w. Schweizerische Bauzeitung—March 26, April 2, 1898. No. 19835 each B.

Melan Bridge.

Construction of the Topeka Melan Bridge. Illustrates design and construction of a concrete-steel bridge with one span of 125 ft., two of 110 and two of 97.5. 2500 w. Eng Rec—April 16, 1898. No. 19623.

Paris Bridge.

The Bridge of Alexander III., at Paris. Illustrated description of a bridge being built across the Seine, and named for the Czar of Russia. 1000 w. Eng News—April 21, 1898. No. 19698.

Pier Moving.

Moving a Pier of the Bismarck Bridge; Northern Pacific R. R. An account of an important and difficult piece of work recently carried out under the direction of the engineering department of the Northern Pacific R. R. 800 w. Eng News—April 28, 1898. No. 19798.

Rock Island Bridge.

The New United States Rock Island Bridge. Illustrates particularly the details of swing span. 2600 w. Eng Rec—April 2, 1898. No. 19411.

Swing Bridge.

Proposed Design for Campbell Avenue Bridge Over Chicago Drainage Canal. A general description of the design of the superstructure, with illustrations showing the principal details, of plans prepared by the Sanitary District engineers. The plans were finally rejected, but of interest because of the completeness and magnitude of the scheme. 900 w. Ry & Engng Rev—April 23, 1898. No. 19762.

CANALS, RIVERS AND HARBORS.

Breakwater.

Breakwater at Presque Isle Point, Marquette, Michigan. W. H. Hoyt. Illustrated description of somewhat novel construction. 1000 w. Eng News—April 7, 1898. No. 19458.

Dam.

Steel Weir, Ash Fork, Ariz. Describes a dam 184-ft. long and 50-ft. deep, formed of steel frames faced with steel plates. Ill. 900 w. Eng Rec—April 9, 1898. No. 19470.

Danube.

The Completion of the Regulation of the Danube in Lower Austria. (Die Vollendung der Donau-Regulierung in Niederösterreich.) An official report upon the work from 1862 to the present time, especially with regard to the finan-

cial side of the question. 7000 w. Oesterr Monatschr f d Oeffent Baudienst—April, 1898. No. 19845 D.

Dredging.

European Sea-Going Dredges and Deep-Water Dredging. E. L. Corthell. The second paper discusses the conditions which justify dredging together with an account of the resultant commercial benefits. Many illustrations. 3500 w. Engineering Magazine—May, 1898. No. 19936 B.

Flow.

Surface Resistance of Water. H S. Hele-Shaw. Read before the Inst. of Naval Arch'ts, London. Investigations of the nature of surface resistance of water and of stream line motion under certain experimental conditions. Ill. 2200 w. Engng—April 8, 1898. Serial. 1st part. No. 19645 A.

Jetty Construction.

Origin of the Gulf Stream and Circulation of Waters in the Gulf of Mexico, with Special Reference to the Effect on Jetty Construction. N. B. Sweitzer, Jr. Reviews the theories advanced regarding these currents, and gives conclusions from careful observations and from examination of the jetty construction upon the coasts of Texas and Mexico. Ill. 5400 w. Pro of Am Soc of Civ Engs—April, 1898. No. 19780 F.

Levee.

The Shawneetown Levee Disaster. Statement of two possible causes of this fatal accident. 800 w. Eng Rec—April 23, 1898. No. 19720.

Lighthouses.

A Contribution to the History of the Development of the Lighthouse. (Zur Geschichte und Entwickelung der Leuchtfeuer.) An address mainly historical and descriptive delivered by Constructor Veilmeyer before the Society of German Engineers in Berlin. 4000 w. Glaser's Annalen—April 1, 1898. No. 19840 D.

Lock Construction.

The Construction of Lock No. 1. Osage River, Missouri. F. B. Maltby. Illustrated description of the work and the interesting features of the lock. 2200 w. Eng News—April 28, 1898. No. 19797.

Mississippi.

Improvement of the Mouth of the Mississippi River. Thomas L. Raymond. Read before the Louisiana Engng. Soc. Reviews the conditions prevailing at or near the mouth and the methods which have been tried or suggested, and states the advantages of the jetty system. 4000 w. Eng News—March 31, 1898. No. 19314.

New York Canals.

Canal Improvement Postponed. Editorial on the situation in New York state, the legislature having refused to pass a bill to continue the work. 1600 w. Sea—April 7, 1898. No. 19505.

The Prospects of the New York Canals. Editorial discussion of this question and the importance of prompt action by the New York legislature. 1800 w. Eng News—March 31, 1898. No. 19318.

Nicaragua Canal.

Some Engineering Features of the Nicaragua Canal. Alfred Noble. Describes the general features of the region, and gives an outline of the engineering features of the project. Also discussion and maps. 10000 w. Jour W. Soc of Engs—Feb., 1898. No. 19525 D.

Trench Machine.

A New Trench Machine. Illustrated description of a machine of the steel trestle type, put on the market by the Potter Mfg. Co. of Indianapolis. 500 w. Eng News—April 28, 1898. No. 19794.

IRRIGATION.

Central India.

Tank Irrigation in Central India. George Palmer. The second paper shows the arrangement of a typical series of tanks, with illustrations of tanks, weirs, and feeders. 3000 w. Engineering Magazine—May, 1898. No. 19942 B.

Gravitation.

Irrigation by Gravitation Channels from the Subsoil Water. J. E. Hilton. Showing that advantage can be taken of the high level at which the subsoil water stands in some of the submontane districts to convey the water by gravitation to the surface. Ill. 1800 w. Ind Engng—March 26, 1898. No. 19904 D.

MISCELLANY.

Anniversary.

The 50th Anniversary of the Society of Civil Engineers of France. (Le Cinquantenaire de la Société des Ingenieurs Civils de France.) A general historical notice in view of the coming celebration of the semi-centennial of the society. 1200 w. Moniteur Industrielle—April 9, 1898. No. 19876 G.

Carpentry.

The Deformation of Compression Members and the Stability of Large Wooden Frameworks. (Sur la Déformation des Pieces Comprimées et la Stabilité des Grande Charpentes.) A paper by M. Berard discussing the manner in which rupture takes place in wooden framework, based upon the work of deformation which occurs at the time of rupture. 1500 w. Comptes Rendus—April 4, 1898. No. 19824 D.

Cement.

Points on Portland Cement. Considers the chemical components, properties, uses, &c. 1800 w. Stone—April, 1898. No. 19701 C.

Slag Cement, its Production and Properties. (Der Schlackencement, seine Herstellung und Eigenschaften.) E. May. An exhaustive treatment of the methods of making cement from slag as practised in Germany, Austria, Belgium, France, and Russia, with data as to its properties and behavior under test. Two articles. 7500 w. Stahl und Eisen—March 1, April 1, 1898. No. 19850 each D.

Cement Testing.

Causes for the Variation in Cement Tests in

Different Places. (Ueber die Ursachen der Abweichungen in den Festigkeits-Ergebnissen der Cementprufung an Verschiedenen Orten.) M. Gary. An exhaustive paper on the testing of cement and mortars, showing the number of variable elements which enter into the problem and affect the results. An important and valuable paper. 40000 w. Mitt aus d Kgl Tech Versuchsaustalt—Part 1, 1898. No. 19866 G.

Cement Works.

Plant of the Milwaukee Cement Company. Frederick H. Lewis. Illustrates a natural rock cement mill with a capacity of 2800 barrels daily, and describes the Campbell kiln and Berthelet separating system. 2000 w. Eng Rec—April 2, 1898. No. 19410.

The New Plant of the Bronson Portland Cement Company, Bronson, Mich. Frederick H. Lewis. Illustrates and describes features of plant where European methods of handling clay and marl are combined with distinctive American practice of calcination. 3500 w. Eng Rec—April 30, 1898. No. 19955.

Columns.

See Architecture and Building, Miscellany.

Concrete.

Crushing Strength of Concrete with Various Aggregates. Gives results of tests of concrete made with same mortars but various proportions of stone and gravel. 1000 w. Eng Rec—April 9, 1898. No. 19473.

Drainage.

Note on Trellised Drainage in the Adirondacks Albert Perry Brigham. Gives features of the drainage of this region, with map. 900 w. Am Geol—April, 1898. No. 19443 D.

Geology.

On the Relation of Geology to Engineering. Boyd Dawkins. The "James Forrest" lecture, delivered before the Inst. of Civil Engs., England. Considers questions that have been answered by the combined results of both sciences; the movement of water in the rocks, the deposition of superficial débris, the folds, &c. 3600 w. Engng—March 25, 1898. Serial. 1st part. No. 19388 A.

Roads.

Highway Improvement in Rhode Island. Description of state road construction. 1000 w. Eng Rec—April 16, 1898. No. 19622.

Tests of Road Materials. Editorial describing tests employed in Massachusetts and France to determine the relative values of stone for highway construction. 900 w. Eng Rec—April 23, 1898. No. 19718.

The New York Road Improvement Law. A statement of the provisions of the new State act. 800 w. Eng Rec—April 2, 1898. No. 19409

Various Phases of the Road Question. Roy Stone. Considers questions of legislation, of public finance, and the forming of public opinion, methods and importance. Discussion. 8500 w. Pro Engs' Club of Phila—March, 1898. No. 19444 D.

Solar Transit.

A New Solar Transit. Illustrates and describes the operation of an instrument invented by J. B. Davis, which removes the difficulties usually met with in extending its use to land surveys. 1100 w. Eng News—April 28, 1898. No. 19796.

Strength of Wood.

The Relation of the Strength of Wood under Compression to the Transverse Strength. B. E. Fernow. Some of the results obtained from the study of wood and from extensive experiments. 1000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 19522 D.

Tachymeters.

The Cleps-Tachymeters. From "Guide pratique du Géomètre Moderne," by A. Salmoiraghi. Translated by C. McK. Lewis. Illustrated description of instrument and methods of use. Ill. 9500 w. Sch of Mines Quar—Jan., 1898. No. 19914 D.

Timber.

The Timbers of New South Wales. Abstract from the report of the government statistician, T. A. Coghlan, reviewing the timber products of the colony. 1100 w. Eng News—April 28, 1898. No. 19792.

Timber Suitable for Structures in Nicaragua and Costa Rica. Notes gathered from personal observation during residence of two years, and from writings of Spanish authors. 3000 w. Eng News—April 28, 1898. No. 19791.

Topography.

A Rapid Method for Plotting Contours. Emil L. Neubling. Illustrates method of dividing lines rapidly into a given number of parts. 400 w. Eng Rec—April, 1898. No. 19723.

Some Illustrations of the Influence of Geological Structure on Topography. Benjamin Smith Lyman. Calls attention to the relation between surface topography and the geological indications and the value in ascertaining the subterranean structure and economic importance. 1200 w. Jour Fr Inst—May, 1898. No. 19946 D.

Tunnelling.

The Use of the Shield in the Construction of Subways. (Emploi du Bouclier dans la Construction des Souterrains.) R. Godfernaux. A review of the work of M. Legouëz, with especial reference to the great Clichy collecting sewer. 5000 w. La Revue Technique—March 25, 1898. No. 19815 D.

The Use of the Shield in Subway Construction. (L'Emploi du Bouclier dans la construction des Souterrains.) R. Legouëz. Discussing the tunnel work of Brunel, Greathead, Berlier, and others, with the use of improved shield, including tables of rapidity of construction and cost of work for a number of cases. 3000 w. Le Génie Civil—March 19, 1898. No. 19801 D.

Tunnel Shields, Central London Railway. Describes special features of shields 12.5 and 22.8 feet in diameter used in tunneling clay and marl under 20 pounds air pressure. 800 w. Eng Rec—April 23, 1898. No. 19722.

Wheel.

A 360-foot Ferris Wheel. Illustrates the method of erecting a large wheel in Paris. 500 w. Eng Rec—April 23, 1898. No. 19727.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Africa.

The Commercial Importance of the Railway in German South-western Africa. (Ueber die Rentabilität der Deutsch-südwest-afrikanischen Eisenbahn.) A paper by Councillor Schwabe before the German Railway Society discussing the possible profitableness of the road, based upon the nature and products of the country, and showing the necessity of the greatest economy in construction if the interest on the cost is to be met. 7500 w. Glaser's Annalen—March 15, 1898. No. 19837 D.

American Trade.

The Advance of America's Foreign Trade. Editorial examination of the details of America's exports. 1500 w. Engng—April 8, 1898. No. 19643 A.

Bicycles.

Bicycle Trade in Foreign Countries. Reports on the trade in Denmark, Saxony, northern France, northern Spain, southern Italy and in Ontario 2500 w. Cons Repts—April 8, 1898. No. 19463 D.

Brazil.

Brazil: Its Commerce and Resources. Thomas L. Thompson. Sets forth the resources, chief industries and commercial prospects of this country, and the rapid progress being made. 5700 w. Forum—March, 1898. No. 19491 D.

Central America.

Central America: Its Resources and Commerce. William Eleroy Curtis. Discusses the resources of the country and the causes for the failure of the republics to keep pace with the progress of the world in general. Interesting accounts of Guatemala and Salvador. 6000 w. Forum—March, 1898. No. 19494 D.

Chile.

New Chilean Customs Tariff. Statement of duties leviable under the new tariff. 5000 w. Bd of Trd Jour—April, 1898. No. 19784 A.

China.

Affairs in China. Remarks showing the general trend of events and their possible results on trade and industry. 2500 w. Engng—March 25, 1898. No. 19386 A.

China's Complications and American Trade. Clarence Cary. Considers the unfortunate condition of affairs in China, and the effect on trade. 4800 w. Forum—March, 1898. No. 19490 D.

New Trade Regulations in China. A translation of a communication from the Tsungli Yâmen, to the effect that goods sent inland under transit passes may be sold en route. 800 w. Cons Repts—April 7, 1898. No. 19433 D.

Competition.

American Competition and the Question of Transport. (Der Amerikanische Wettbewerb und die Frachtenfrage.) E. Schrödter. A paper before the convention of the *Verein Deutscher Eisenhüttenleute*, showing the important relation which the cost of transport bears to the successful meeting of American competition in the iron trade. 7500 w. Stahl und Eisen—March 15, 1898. No. 19854 D.

Cuba.

The Foreign Commerce of Cuba. Showing the limitations imposed on Cuban foreign commerce, and the terrible results of the insurrection to the commercial interests of the island. 4800 w. Harper's Wk—April 9, 1898. No. 19455.

Exports.

Exports and Wages. Jacob Schoenhof. Considers the effect of wages on the export trade of a country, compares the exports of England and Germany, and studies the question of industrial prosperity in the United States. 4500 w. Forum—Jan., 1898. No. 19484 D.

Failures.

Failures Smaller Than for Four Years Past. Reports fewer business failures, smaller liabilities, and lessened assets of those failing, during the first quarter of this year, than in the corresponding periods of any year since 1893. 900 w. Bradstreet's—April 2, 1898. No. 19356.

Far East.

European Powers in the Far East. Editorial on affairs in the far east and a short synopsis of the concessions recently obtained from China. 2000 w. Engng—April 15, 1898. No. 19744 A.

The Markets of the Far East. Summary of replies to a letter of inquiry sent to leading exporters and importers, referring to general trade conditions. 1000 w. Cons Repts—April 20, 1898. No. 19686 D.

German Trade.

Development of German Trade in the Far East. Considers some of the facts relating to its growth. 700 w. Bd of Trd Jour—April, 1898. No. 19781 A.

Germany.

German Manufactures. Raphael-Georges Levy. Translated from *Revue des Deux Mondes*. A study of the recent progress, and the relation of German industry to the United States. 2500 w. Chau—May, 1898. No. 19910 C.

Hong Kong.

Foreign Competition in Hong Kong. Editorial on the effect on the condition of British trade of the present commercial and industrial movement. 2500 w. Engng—April 1, 1898. No. 19529 A.

Leather.

The German Leather Industry. States the preference for American dressed leather and shows that manufacturers have an opportunity to gain a permanent foothold. 600 w. Cons Repts—April 2, 1898. No. 19368 D.

New York Commerce.

The Decaying Commerce of New York and How to Restore it. Thomas C. Clarke. Discusses the work on canals in Canada, and the danger to New York commerce; and suggests

two routes which would enable New York to meet this competition. One connecting Lakes Erie and Michigan ; the other the extension of the Ottawa route through Lake Champlain and the upper Hudson. 1600 w. Eng News—March 31, 1898. No. 19313.

Paris Exhibition.

The Paris Exhibition of 1900. Editorial on the conditions, privileges, and restrictions that will attend the admission of exhibits. 2500 w. Engng—April 15, 1898. No. 19742 A.

Permanent Exposition.

United States Warehouse in Venezuela. An account of the opening of the permanent exposition of American wares at Caracas, under the auspices of the Nat. Assn. of Mfrs. of the U. S. A. Addresses, extracts from press notices, &c. 4000 w. Cons Repts—April 18, 1898. No. 19641 D.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Showing fluctuations in quotations from July 1, 1895, to April 1, 1898. Also remarks on the check to rising prices due to unsettled conditions of foreign relations, and other causes. 3500 w. Bradstreet's—April 9, 1898. No. 19481.

Russia.

American Trade in Russia. Suggests some American articles that would find a market in Russia, gives information of how the competition of Germans in Russia is organized and other matters concerning trade. 1200 w. Ir Age—April 28, 1898. No. 19799.

Siam.

Trade and Trade Routes in Siam. Information of the trade of Siam, which is of importance because of its geographical position, giving values of exports and imports, and of the trading centers, &c. 2000 w. Bd of Trd Jour—April, 1898. No. 19782 A.

Tariff.

Tariff Changes and Customs Regulations. United Kingdom, Russia, Netherlands, Germany, France, Spain, Italy, Switzerland, Bulgaria, United States, Chile, British India, St. Lucia, Mauritius, Natal and Tasmania. 3800 w. Bd of Trd Jour—April, 1898. No 19785 A.

The True Meaning of the New Sugar Tariff. Harvey W. Wiley. A review of the sugar tariff, making an attempt to explain the true meaning of the law. 4000 w. Forum—Feb., 1898. No. 19487 D.

Transportation.

The Improvement of Transportation in Country Districts. E. E. Russell Tratman. Read at meeting of the Illinois Soc. of Engs. & Surv. Discusses roads and their improvement, the building of a railway, &c. 2200 w. Brick—April, 1898. No. 19454.

Tunis.

British Trade with Tunis. Particulars taken from report of Sir H. H. Johnston, Consul-General at that place. 1600 w. Bd of Trd Jour—April, 1898. No. 19783 A.

War.

War and Business. Editorial considering the effect of war with Spain upon the business prosperity of the United States. 1500 w. R R Gaz—April 1, 1898. No. 19348.

West Indies.

The West Indies and Sugar Bounties. Nevile Lubbock. An account of the present condition of the West Indies, and a presentation of the case of sugar bounties, describing the effect which these bounties have had on the British colonies, Great Britain and the continent, and denouncing them. Discussion. 9500 w. Jour Soc of Arts—April 1, 1898. No. 19552 A.

CURRENCY AND FINANCE.

Bimetallism.

The Future of Bimetallism. G. G. Vest. Favoring bimetallism and discussing the position of the advocates of the gold standard. 2800 w. Forum—Jan., 1898. No. 19482 D.

Haitian Loan.

Haitian Loan Negotiations. Copy of a law passed by the last Legislature of Haiti for the purpose of negotiating a loan in the United States and for retiring the paper money. 3000 w. Cons Repts—April 13, 1898. No. 19577 D.

India.

Currency and the Money Market in India. Showing how the position is viewed in India, and describing the conditions which differ strikingly from those of England. 7000 w. Banker's Mag, Lond—April, 1898. No. 19497 B.

India on a Gold Basis. W. R. Lawson. An explanation of the currency question in India, and the crisis through which it is passing. 4800 w. Contemporary Rev—April, 1898. No. 19582 D.

GOVERNMENTAL CONTROL.

Swiss Railroads.

The Referendum and the Swiss Railroads. J. R. Macdonald. Republished from the *New Age*, London. An account of the railways of Switzerland and their purchase by the Government. 2000 w. Am Rev of Revs—April, 1898. No. 19351 C.

LABOR.

Arbitration.

Arbitration in Mining Disputes. Arbitration as controlled by English mining laws, giving cases. 2700 w. Col Guard—March 25, 1898. No. 19380 A.

Industrial Arbitration in Congress. Carroll D. Wright. An explanation of bill pending in Congress, showing how it differs from the law of 1888, and analyzing it. 4000 w. Gunton's Mag—April, 1898. No. 19500 C.

Credit Union.

The German Credit Union. Extracts from a paper by James G. Cannon, read before the Philadelphia Credit Men's Assn. 1600 w. Ir Age—April 7, 1898. No. 19436.

Factory Labor.

Factory Labor in the South. The conditions

existing in the south, and the need of changes. A reply to an article published in the Atlanta *Constitution*. 4800 w. Gunton's Mag—April, 1898. No. 19499 C.

Japan.

The First Railway Strike in Japan. Eli West. A brief account of the labor trouble and its outcome. 1000 w. Ry Age—April 22, 1898. No. 19735.

Labor Movement.

Women and the Labor Movement. M. E. J. Kelley. Presents the importance of bringing women to a knowledge of their social responsibilities and duties, discusses women as wage-earners, women of leisure, and the home-keeping women, and the influence of each class. 3800 w. N Am Rev—April, 1898. No. 19358 D.

Labor Question.

An Industrial Lesson, S. N. D. North. An examination of the causes of the English engineering strike and lock out, and a discussion of the strike and its outcome. 4500 w. Ap Pop Sci M—April, 1898. No. 19308 D.

Society Reports.

Steam Engine Makers' Society. The first report of the trade-union societies involved in the late strike, and containing much of interest on this subject, is discussed. 2500 w. Engr, Lond—March 25, 1898. No. 19389 A.

Strike.

The Coal Strike. Discussing some phases of the South Wales coal strike. 2500 w. Engr, Lond—April 15, 1898. No. 19752 A.

Trade Unions.

A Study in Trade Unionism. Benjamin Taylor. Discusses the methods of the unions as brought out in the recent engineering strike and their present degrading influences. 7000 w. Nineteenth Cent—April, 1898. No. 19608 D.

Wages.

Wage Changes in England. Discusses statistics from the British Board of Trade reports. 1600 w. Gunton's Mag—April, 1898. No. 19501 C.

Working Class.

The Condition of the American Working-Class: How Can It Be Benefitted? Frank K. Foster. The labor problem and its perplexities are discussed. 5800 w. Forum—Feb., 1898. No. 19488 D.

The Incorporation of the Working-Class. Hugh McGregor. Reviews the struggles of the laboring classes, comparing the conditions of the present and past, and showing the progress of trades unions, and their effect on improving the conditions of the workers. 5500 w. Forum—Jan., 1898. No. 19485 D.

MISCELLANY.

Copyright.

See Architecture and Building, Miscellany.

Modern Industry.

Is There Work Enough for All? William T. Harris. The article deals with the needed readjustment of vocations, due to mechanical invention and changed conditions. 4400 w. Forum—April, 1898. No. 19495 D.

Sugar Industry.

Should the United States Produce its Sugar? James Wilson. Discussing whether it is a wise policy for the people of the United States to produce their own sugar; concluding in its favor. 3000 w. Forum—March, 1898. No. 19489 D.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Electro-Chemistry.

Some Notes on Electro-Chemistry. J. Wright. Historical review of early experiments in this industry, with description of some of the processes to which the art is applied. 3000 w. Ind & East Engr—March, 1898. No. 19681 D.

The Results of Organic Electro-Chemistry. (Die Erfolge der Organischen Elektrochemie.) Dr. M. Krüger. The beginning of a general review of the progress which has been made in the application of electrolysis to organic analysis. 2500 w. Elektrochemische Zeitschr—April 1, 1898. No. 19885 D.

Electrolysis.

Conductivity in Mixed Solutions of Electrolytes. (Ueber Stromleitung in Gemischten Lösungen von Elektrolyten.) K. Hopfgartner. Showing the influence which various proportions of mixed electrolytes have upon the results of electrolytic analysis. 3000 w. Zeitschr f Elektrochemie—April 5, 1898. No. 19883 H.

The Electro-Analytic Separation of Silver from a Nitric Acid Solution, and its Separation from Copper. (Ueber die Elektro-Analytische Abscheidung des Silbers aus Salpetersaurer Lösung und die Trennung Desselben von Kupfer.) F. W. Kuster & H. von Steinwehr. Showing the results with different voltages and temperatures, and describing the methods employed. 2500 w. Zeitschr f Electrochemie—April 5, 1898. No. 19884 H.

The Electrolytic Laboratory at the Imperial Mining Academy at Leoben. (Die Elektrolytische Einrichtung an der k. k. Bergakademie in Leoben.) Dr. H. Paweck. An account of the very complete apparatus at the Austrian Mining Academy for instruction in the application of electrolysis to the separation of metals. Two articles, 1 plate. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 19, 26, 1898. No. 19872 each B

Studies in the Electrolytic Reduction of the Nitro Group. (Studien über die Elektrolytische Reduktion der Nitrogruppe.) Walther Löb. Giving the methods and results of a valuable series of experiments in the electrolytic reduction of the nitro organic compounds. 6000 w. Zeitschr f Elektrochemie—March 20, 1898. No. 19882 H.

Electro-Metallurgy.

Notes on the Moebius Processes for Parting Gold and Silver, as Carried on at the Guggenheim Smelting Works at Perth Amboy, N. J. Percy Butler. The processes of this establishment are described as all are dependent on one another. The plant is described and illustrated. 4500 w. Can Min Rev—March, 1898. No. 19374 C.

Electro-Plating.

Electrical Equipment of Plating Plants. C. F. Burgess. Comments on the fact that this branch of electrical industry has not shared the rapid development of other electrical industries, and reviews the work, offering suggestions and conclusions. 3300 w. W Elect'n—April 2, 1898. No. 19425.

The Electroplating of the Dome of the Philadelphia City Hall Tower. Abstracted from a paper read before the Engineers' Club of Philadelphia by Francis Schumann. The electroplating had to cover some 120,000 sq. ft. of surface, and included pieces weighing about 10,000 lbs. each. It required nearly fifty months of actual time, working both day and night. 1000 w. Elec Wld—April 16, 1898. No. 19589.

LIGHTING.

Electric Lamp.

The Welsbach Electric Lamp. Concerning the latest invention of Dr. C. Auer von Welsbach. 1700 w. Jour Gas Lgt—April 19, 1898. No. 19908 A.

English Plants.

Statistics on English Electric Lighting Plants. Claud P. D'Oyly. Part first states the present conditions in England and some of the results of operation of various plants. 1800 w. Elec Eng, N. Y.—April 14, 1898. Serial. 1st part. No. 19575.

Lamps.

Two-Hundred Volt Lamps. Editorial on the change from 100 to 200-volt lamps in England, and giving conclusions from the discussion of Bingswanger Byng's paper before the Inst. of Elec. Engs. 1500 w. Engng—March 25, 1898. No. 19383 A.

Municipal Lighting.

The Commercial and Business Aspects of Municipal Electricity Supply. Alfred H. Gibbings. Discussing what has been attempted or accomplished toward increasing the advantages for consumers and at the same time reducing costs, with related matters of interest. 2200 w. Elect'n, Lond—April 8, 1898. Serial. 1st part. No. 19662 A.

Photometry.

Station Photometry. Buckner Speed. Detailed directions for the construction and operation of a central station photometer department. 3000 w. Elec Wld—April 9, 1898. No. 19451.

Rates.

Rates for Electric Lighting. E. L. Wells, Jr. Read before the Texas Gas and Elec. Lgt. Assn. Discusses the advantages and disadvantages of the various systems. Also discussion by members. 6200 w. Am Gas Lgt Jour—April 25, 1898. No. 19737.

Sign Switching.

Electrical Sign Switching. George T. Hanchett. Shows a few expedients in sign manipulation that have cheapness and adaptability to recommend them. Ill. 1400 w. Am Elect'n—April, 1898. No. 19448.

Torquay Works.

Torquay Municipal Electricity Works. Illustrated description of a high pressure alternating current supply system. 2000 w. Elec Rev, Lond—April 1, 1898. No. 19542 A.

POWER.

Accumulators.

Fribourg Accumulator Plant. Describes and illustrates a plant in Switzerland. 900 w. W Elec—April 2, 1898. No. 19474.

Some Recent Improvements in Accumulators and Their Application to Traction on Common Roads. J. T. Niblett. Abstract of a paper read before the Self-Propelled Traffic Assn., Liverpool Centre. Deals especially with propulsion by means of batteries, the recent improvements, how best employed, &c. 1800 w. Elec Rev, Lond—April 8, 1898. Serial. 1st part. No. 19669 A.

Cranes.

See Mechanical Engineering, Shop & Foundry.

Electrical Energy.

The Cost of Generation and Distribution of Electrical Energy. R. Hammond. Abstract of paper read before the Inst. of Elec. Engs., London. Facts from the official returns of electric supply works. 2000 w. Col. Guard—April 1, 1898. No. 19535 A.

Electric Plant.

The Plant of the Ellicott Square Building. F. L. Wilson. Illustrates and describes the mechanical and electrical plants of this large building in Buffalo, N. Y. 3500 w. Elec Wld—April 30, 1898. No. 19787.

Electric Power.

Matters Affecting the Cost of Electric Power. H. P. Elliott. Digest of a paper showing the great influence of the variable load upon the cost, and the relation of the various items that enter into the cost of production. 1600 w. Can Elec News—April, 1898. No. 19506.

Electricity in Ships.

See Marine Engineering.

Electric Transmission.

The Electric Transmission of Water Power. William Baxter, Jr. Presents examples of electrical transmission of water powers to distant points where they can be utilized, showing that it has passed far beyond the experimental stage. Also considers the results that may follow. Ill. 3800 w. Ap Pop Sci M—April, 1898. No. 19309 D.

Fan Motors.

Fan Motor Problems and Some of Their Solutions. Technical description of many of the various makes of fan motors. Ill. 3000 w. Elec Wld—April 2, 1898. No. 19332.

Generators.

The Determination of the Size and Number of Turns of Wire in a Constant Potential Generator. William Baxter, Jr. Shows how to develop a practically constant pressure and explains the principles upon which the winding of constant potential generators depend. 2000 w. Am Mach—April 14, 1898. No. 19585.

Motors.

Alternating-Current Motors. E. E. Tasker. Read at the students' meeting of the Inst. of Elec. Engs., London. Illustrated explanation of the working of an alternating-current generator and motor, and the various devices used. 4000 w. Elec Eng, Lond—April 1, 1898. Serial. 1st part. No. 19549 A.

The Determination of the Size and Number of Turns of Wire in a Constant Speed Motor. William Baxter, Jr. Considers the principles of operation and the winding of the wire of a constant speed motor. Diagrams. 2000 w. Am Mach—March 31, 1898. No. 19311.

The Regulation and Protection of the Electric Motor. Harry H. Cutter. Paper read before the Chicago Elec. Assn. Discusses various methods for the regulation of motors and the means of properly protecting from damage. 4800 w. Elec, N. Y.—April 13, 1898. No. 19581.

Polyphase Circuits.

Three-Phase Machinery. William Mayo Venable. Facts about polyphase circuits with description of types of three-phase machinery. Ill. 1600 w. W Elect'n—April 9, 1898. No. 19563.

Power Plant.

Power Plant with Electric Transmission at Delta, Pa. S. R. Stubbs. A short description of a small but interesting plant. 900 w. Eng News—April 21, 1898. No. 19695.

The Hydro-Electric Power Plant of Grenada, Spain. (Usine Hydro-Electrique de Grenade.) R. B. Ritter. An extended account of this important plant. A fall of 100 meters is utilized to obtain 1750 h. p. from the Rio Genil. 3500 w. 1 plate. Le Génie Civil—April 2, 1898. No. 19806 D.

The Helena Power Development. Illustrates plant on the Missouri River for developing 10,000 h. p. 1200 w. Eng Rec—April 16, 1898. No. 19626.

See Mechanical Engineering, Power and Transmission.

Shop Power.

See Mechanical Engineering, Shop & Foundry.

Storage Batteries.

The Electric Storage Battery Co.—Its Factory and Its Battery Installations. Joseph Wetzler. An account with many illustrations, of the factory and methods of manufacture of this company and some of the plants installed. 9900 w. Elec Eng, N. Y.—April 28, 1898. No. 19771.

Tanneries.

Electrical Transmission in Tanneries. An account of a number of tanneries which have been electrically equipped. Ill. 2300 w. Elec Eng, N. Y.—April 7, 1898. No. 19428.

Transformers.

Lowering Transformers for Niagara Power. J. S. Peck. Illustrated description of the large transformers recently furnished the Cataract Power & Conduit Co. of Buffalo, N. Y., and the method of regulation employed. 2000 w. Elec Wld—April 9, 1898. No. 19450.

The Efficiency of the Alternating Current Transformer. Alexander Russell. Describes a graphical method of finding the efficiencies of a transformer at all loads which is simple and gives accurate results. 1700 w. Elect'n, Lond—March 25, 1898. No. 19398 A.

Transmission.

A 1000 Horse Power High Voltage Transmission Experiment at Ogden, Utah. Describes an interesting experiment made to ascertain the limits within which high voltage currents might be used commercially. 600 w. Elec Eng, N. Y.—April 28, 1898. No. 19772.

The Pioneer Electric Power Transmission. Illustrated description of the transmission plant for utilizing the water power of Ogden Canyon, Utah. 4200 w. Jour of Elec—March, 1898. No. 19426.

See Electrical Engineering, Power.

TELEGRAPHY AND TELEPHONY.

Cable Capacity.

Notes on the Ballistic Determination of the Capacity of Coiled Cables. Arthur Dearlove. Discusses "double ending" the cable, and the satisfactory results, giving details of experiments made. 900 w. Elect'n, Lond—April 8, 1898. No. 19661 A.

Electric Arc.

The Electric Arc as a Telephone. Reports some curious experiments, described by Hermann Th. Simon, in *Wied. Ann.*, which show that the electric arc is capable of acting either as a telephone transmitter or as a receiver. 500 w. Elec Rev, Lond—March 25, 1898. No. 19395 A.

Inductance.

Inductance in Telephony. W. Moon. Deals with inductance effects apart from capacity. 700 w. Elec Rev, Lond—April 15, 1898. Serial. 1st part. No. 19769 A.

Recorder.

The First Telegraph Recording Register. Illustration and statement concerning the first telegraph recording register on which was received the first message, with copy of agreement between S. F. B. Morse and Alfred Vail. 1200 w. Elec Rev, N. Y.—April 27, 1898. No. 19773.

Space Telegraphy.

Experiments with Spark Telegraphy. K. Strecker. Abstract of a paper read before the *Elektrotechnischer Verein.* Describes an experiment with the Hughes type-printer, and improved connections for Morse instruments. Ill. 800 w. Elect'n, Lond—April 8, 1898. No. 19663 A.

Hertz Wave Signalling in War. Charles T. Child. Shows that this method of communication is not yet ready for service as a military

auxiliary. 900 w. Elec Wld—April 30, 1898. No. 19789.

Telegraphy Across Space. Silvanus P. Thompson. A lecture giving an excellent explanation of this subject, discussing conduction methods, induction methods, and wave methods. 5400 w. Jour. Soc of Arts—April 1, 1898. No. 19553 A

The New Telegraphy. A. Slaby. Gives recent experiments in telegraphy with sparks, showing also the shortcomings and weaknesses of the system, but regarding the subject hopefully. Ill. 4500 w. Century Mag—April, 1898. No. 19336 D.

Wireless Telegraphy. Illustrates and explains the apparatus designed by W. J. Clarke, of the United States Electrical Supply Co., of New York, suitable for the requirements of wireless telegraphy. 1200 w. Sci Am—April 2, 1898. No. 19325.

Telautograph.

Locating Submarine Mines by Means of the Telautograph. Editorial on an article in the Chicago *Times-Herald* in which Prof. Elisha Gray describes an ingenious arrangement by which the telautograph could be adapted for locating the exact position of an enemy's vessel. 1200 w. Elec, N. Y.—April 13, 1898. No. 19580.

Telephone.

How to Select a Telephone. H. P. Clausen. Discussion of this subject and of the work intended to be done by the apparatus. 2200 w. W Elect'n—April 9, 1898. No. 19565.

Telephone Exchange.

The Independent Telephone Exchange at La Crosse, Wis. J. R. Cravath. Illustrated description. 1100 w. Elec Eng, N. Y.—April 14, 1898. No. 19574.

The John Street Exchange of the New York Telephone Company. Information concerning an exchange recently put in service in New York. 1600 w. Elec Wld—April 16, 1898. No. 19588.

Telephone Lines.

Locking and Unlocking Devices on Party Telephone Lines. H. S. Webb. Illustrated description of the mechanism for locking all the telephone switches except the one called up by the exchange operator, and then for unlocking them all when the line is free. 900 w. Elec Wld—April 16, 1898. No. 19587.

Telephone Plant.

The New Bell Telephone Plant in St. Louis, Mo. Fred. E. Bausch. Describes and illustrates a complete modern conduit system and underground service, with building and plant. 4400 w. Elec Eng, N. Y.—April 21, 1898. No. 19682.

Zurich Fire.

Fire at the Central Telephone Station of Zurich. C. Du Riche Preller. Gives an account of unusual and very remarkable circumstances which caused the fire, and the destruction which in the station alone is estimated at one million francs. 1000 w. Engng—April 8, 1898. No. 19644 A.

MISCELLANY.

Club House.

The Electrical Equipment of the New York Athletic Club House. Illustrated description of the electrical and mechanical equipment, with criticisms. The building is located at the southeast corner of Sixth avenue and Fifty-ninth street. 2200 w. Elec Wld—April 16, 1898. No. 19586.

Electrical Education.

Electrical Engineering at Columbia University. Francis B. Crocker. Brief illustrated description of the new engineering building, and the fine facilities for study in the various branches. 3000 w. Sch of Mines Quar—Jan., 1898. No. 19915 D.

Electrical Industry.

Through English Eyes. Notes on electrical manufacture in the United States, giving an account of visits to various works. 1500 w. Elec Rev, N. Y.—April 20, 1898. No. 19683.

Electrical Progress.

Electrical Advance in the Past Ten Years. Elihu Thomson. Interesting review of the great progress in the electrical industries, and in the science of electricity. 6000 w. Forum—Jan., 1898. No. 19483 D.

Electric Furnace.

The Electric Furnace. John Trowbridge. Reviews some of the processes affected by the electric furnace, and its great advantage over other furnaces in its power to localize the heat in a narrow compass. 2000 w. Chau—May, 1898. No. 19911 C.

See Mining and Metallurgy, Iron and Steel.

Insulation.

Experiments on the Disruptive Strength of Insulating Materials. Charles P. Hidden and Olaf M. Kelly. Graduation thesis. Gives results of a series of experiments made to measure as accurately as possible the electric pressures required to disrupt specimens of common insulating materials under conditions similar to those encountered in practice. 2200 w. Stevens Ind—April, 1898. No. 19713 D.

Insulation and Conduction. Reginald A. Fessenden. Read before the Am Inst of Elec Engs. Gives an account of the manner in which the current passes through materials, and discusses the purposes for which insulation is used, and the substances best suited to each case. 3300 w. Elec Wld—April 2, 1898. No. 19324.

Magnets.

On the Temperature Coefficients of Certain Seasoned Hard Steel Magnets. Arthur Durward. Reports a series of experiments on a large number of glass-hard magnets made of different kinds of steel and carefully seasoned. Tabulated results. 2000 w. Am Jour of Sci—April, 1898. No. 19343 D.

Meter.

New Electric Meters. (Neuer Elektrizitatszähler.) A description of the electricity meter of Dr. H. Aron; an electric pendulum and escapement system is used. 1200 w. Elektrotech Rundschau—April 15, 1898. No. 19880 B.

Oscillatory Currents.

Oscillatory Currents and Some of Their Phenomena. E. F. Northrup. Describes the general methods and the construction of the necessary apparatus for obtaining oscillatory currents and their effects. 3800 w. Elec Wld—April 30, 1898. Serial. 1st part. No. 19788.

Potential.

The Graphical Method of Representing Alternating Potentials. (Ueber die Graphische Darstellung des Wechselpotentials und ihre Anwendung.) H. Görges. An elaborate geometrical system of showing alternating potentials, describing the method of application. 5000 w. Elektrotechnische Zeitschr—March 17, 1898. No. 19887 B.

Rotating Fields.

The Production of Rotating Fields by Foucault Currents. (Ueber die Entstehung Rotirender Magnetfelder durch Foucaultströme.) F. Braun. Describing the apparatus used for producing rotating fields and also the methods for examining them. 2500 w. Elektrotechnische Zeitschr—March 31, 1898. No. 19890 B.

Thermometry.

The Determination of Low Temperatures. (Die Bestimmung Tiefer Temperaturen.) G. W. Meyer. Describing an electrical method based on the diminution of electrical resistance with reduction in temperature. 2000 w. Elektrochemische Zeitschr—April 1, 1898. No. 19886 D.

MARINE ENGINEERING.

Cargo Steamers.

The Designing of Cargo Steamers. Aragh E. Long. Abstract of paper read at the meeting of the North-East Coast Inst. of Engs. & Shipbuilders, at Newcastle-on-Tyne. Considers dimensions, form, and other questions. 2000 w. Steamship—April, 1898. No. 19551 A.

Copper Pipes.

Brazed Copper Steam Pipes. Editorial on the accident to the steam pipe of the Prodano, and the investigations recently made by Prof. Arnold, for the committee of Lloyd's Register of British and Foreign Shipping. 1700 w. Engng—April 15, 1898. No. 19743 A.

The Failure of Copper Steam Pipes. Remarks of the chief engineer surveyor of Lloyd's Register of British and Foreign Shipping, respecting Prof. Arnold's report on the exploded steam pipe of the ss. Prodano. 4800 w. Engr, Lond—April 15, 1898. No. 19753 A.

Cymric.

New White Star Freight and Passenger Transatlantic Liner Cymric. Brief illustrated description of the largest freight steamship afloat. 700 w. Marine Engng—April, 1898. No. 19510 C.

Ferry Steamers.

Ice Crushing and Ferry Steamers at the Straits of Mackinac. W. D. Hulbert. Illustrated description of vessels built by the Detroit Dry Dock Co. for winter navigation through fields of heavy ice. 1300 w. Marine Engng—April, 1898. No. 19512 C.

Foundering.

The Foundering of the Japanese S. S. Tai Hoku. Cecil Lightfoot. Letter giving an account of the catastrophe and four snapshot photographs. 1400 w. Ind & East Engr—March, 1898. No. 19680 D.

Great Lakes.

The Great Lakes and the Modern Navy. J. H. Gibbons. Shows that the development of the iron and steel industry of this region of the United States has an important effect on shipbuilding; discusses the projects to connect the lakes with sea by improvements in canals, and the result this would have on our merchant marine, &c. 4000 w. N Am Rev—April, 1898. No. 19359 D.

Marine Engines.

Reminiscences of Early Marine Steam Engine Construction and Steam Navigation in the United States of America from 1807 to 1850, Charles H. Haswell. Read at meeting of the Inst. of Naval Archts., London. Historical account of types used and general progress in construction and design. 3300 w. Engr, Lond—April 1, 1898. No. 19540 A.

Maritime Congress.

The Congress of the Technical Maritime Association (Congres de l'Association Technique Maritime.) M. Hachebet. A general report of the convention recently held at Paris, with brief abstracts of the more important papers presented. 1500 w. Le Génie Civil—April 2, 1898. No. 19807 D.

Paddle Wheels.

Paddle Wheels. A. S. Mills. Read at meeting of the Bristol Channel Centre of the Inst. of Marine Engs., at Cardiff. Abstract of paper and discussion. Discusses the early forms of these wheels and their development. 2800 w. Steamship — April, 1898.. No. 19550 A.

Propelling Machinery.

The Engines of the French Cruiser Brennus. Camille Roche. Abbreviated description from the *Revue de Mecanique*, with illustrations. 700 w. Engr, Lond—April 1, 1898. Serial. 1st part. No. 19536 A.

Raising Vessels.

The Waller Tube for Raising Sunken Vessels. Ernest A. Sjöstedt. Describes the apparatus invented by P. A. Waller, a Swedish engineer, as exhibited at the Stockholm Exposition. The "Södra Sverige," a vessel raised by this method from a depth of some 183 ft. was also exhibited. 1500 w. Ir Age—April 7, 1898. No. 19438.

Sailing Vessels.

The Future of the Sailing Ship. Editorial on

the economical causes of the collapse of this industry in Great Britain. 1700 w. Engr, Lond—March 25, 1898. No. 19391 A.

Sheathing.

On the Direct Attachment of Copper Sheathing Plates to the Hulls of Vessels. Leopold Roper. Read at session of the Inst. of Naval Arch'ts., England. Describes Roper's system of coppering steel ships, which the writer claims approaches nearer to the ideal than any other known system. 2500 w. Ind & Ir—April 15, 1898. No. 19757 A.

Southern Ports.

New Orleans and Galveston. Considers the improvements, and their growing importance in the export business. 1500 w. Transport—April 1, 1898. No. 19547 A.

Steamship Communication.

Steamship Communication Between New York and Buenos Ayres. Presents the conditions to be considered under existing American law, in establishing a fortnightly fast mail service between these ports. 3000 w. Cons Repts—April 12, 1898. No. 19566 D.

Tonnage.

Tonnage and Its Measurement. Refers to Mr. Ramage's paper on "Minimum Net Register and its Effect on Design," and to Mr. W. Hök's paper on "The Trunk-Deck Steamer Oscar II," and the exposure of tonnage cheating. 2500 w. Engr, Lond—April 15, 1898. No. 19750 A.

Trunk Steamer.

Trunk Deck Steamer "Oscar II." W. Hök. Read before the Inst. of Naval Archt's, England. States the principles which form the basis for the construction of trunk-deck vessels, showing the differences between this type and ordinary vessels, giving particulars of the steamer named. Ill. 3800 w. Engng—April 15, 1898. No. 19741 A.

Twin-Screws.

Experiments on the Effect of Direction of Turning in Twin-Screws. R. E. Froude. Read before the Inst. of Naval Archt's. Gives results of model experiments on the comparative efficiency of the two directions of turning. 1200 w. Engng—April 1, 1898. No. 19531 A.

Valve Gear.

Single-Eccentric Valve-Gears for Marine Engines. (Beitrag zur Praktischen Konstruktion der Einexzeuter-Umsteuerungen für Schiffsmaschinen.) Von Berling. A general investigation of the so-called "radial" valve gears, including nearly every variety used in marine practice; with valve diagrams and illustrations of constructive details. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—April 2, 9, 1898. No. 19829 each D.

Yacht.

Details of Construction of the Twin-Screw Steam Yacht Niagara. Information and exact data concerning this fine vessel being built for Howard Gould, of New York. Ill. 1200 w. Marine Engng—April, 1898. No. 19511 C.

Yashima.

The Steering Qualities of the Yashima. Philip Watts. Read at session of Inst. of Naval Archt's, England. Reports a series of turning trials. 1400 w. Engr, Lond—April 15, 1898. No. 19754 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Test.

Test of a Vertical Boiler. George H. Barrus. Tested while running under ordinary service conditions. 600 w. Eng Rec—April 2, 1898. No. 19416.

Bracing.

Bracing Boiler Heads. An article prepared in compliance with a request for tables for calculating the number of braces required in staying boiler heads, when the braces are an inch and one-eighth in diameter. 1200 w. Locomotive—March, 1898. No. 19629.

Evaporation.

Evaporation. W. N. Twelvetrees. Extract from a paper before the mechanical engineers of London, Eng., on the theory and practice. 800 w. Bos Jour of Com—April 23, 1898. No. 19732.

Feed Water.

Heating Feed-Water. Editorial giving history of this discovery, and discussing the problem. 1500 w. Engr, Lond—April 8, 1898. No. 19659 A.

Furnaces.

Refractory Furnace Surfaces. W. H. Booth. Gives the writer's views on the importance of refractory lining and the faults in the present system of firing. 1200 w. Am Mach—April 28, 1898. No. 19927.

Oil Fuel.

Oil Fuel for Steam Generators. A. M. B. Describes apparatus designed to meet the conditions of supplementary service. Ill. 2400 w. Ry Wld—April 7, 1898. No. 19639 A.

Water-Tube Boilers.

Description of Some Experiments with a Water-Tube Boiler. A. F. Yarrow. Describes some experiments made last year, and shows the advantage of the new feed system. Ill. 1800 w. Engng—April 1, 1898. No. 19530 A.

The Use of Water-Tube Boilers in Steel and Iron Works. John Jardine. From a paper read before the West of Scotland Iron and Steel Inst. The demand for higher pressures and the economy to be effected by the use of these boilers; their safety and the possibility of utilizing the waste heat. 2200 w. Col Guard—April 15, 1898. No. 19748 A.

Working Results with Belleville Boilers in Twin S. S. Kherson. G. Gretchin. Abstract of "Notes" communicated to the Inst. of Engs. & Shipbuilders in Scotland, with editorial. A record of personal experience and observation. 5300 w. Engr, Lond—April 1, 1898. No. 19538 A.

COMPRESSED AIR.

Air Transmission.

Practical Application of High Range Compressed Air Power Transmission. Frank Richards. Describes the machine and the system by which the compressor receives the air returning from whatever it is employed to drive, and compresses it to a still higher pressure, sending it out again to do more work. Ill. 1800 w. Am Mach—April 28, 1898. No. 19929.

Compound Compressors.

The Proportions of Compound Air Compressor Cylinders to Secure Best Economy.—Economy of Compounding. F. A. Halsey. Demonstrates that the proportion of cylinders which divides the work equally also secures the greatest saving possible from compounding. 1500 w. Am Mach—March 31, 1898. No. 19310.

Compressed Air.

See Military Engineering.

Liquefied Air.

Liquefied Air. Sol. D. Benoliel. Gives an account of the work of Charles Tripler, with references to the patents of Dr. C. Linde, of Germany, and W. Hampson, of England, and describes investigations of the properties. 1800 w. Elec Eng, N. Y.—April 14, 1898. No. 19576.

Liquid Air. Walter H. Dickerson. Remarks on conditions necessary for reducing gases to the liquid state, with explanation of the process of Charles E. Tripler and description of interesting experiments. 4800 w. Stevens Ind—April, 1898. No. 19715 D.

Liquid Air. W. C. Peckham. Describes three methods of measuring low temperatures, giving experiments. 1200 w. Sci Am—April 23, 1898. No. 19694.

Liquid Air as a Blasting Explosive. J. A. Ewing. Extract from a paper read before the Society of Arts, London, on "Linde's Method of Producing Extreme Cold and Liquefied Air." Refers to its use as an explosive by mixing it with carbon. Ill. 1800 w. Col Guard—March 18, 1898. No. 19642 A.

The Commercial Manufacture of Liquid Air. An account of the methods by which liquid air is now manufactured with ordinary commercial apparatus and at a comparatively small cost. Describes apparatus used by Chas. E. Tripler. Also editorial. 4000 w. Eng News—April 14, 1898. No. 19598.

Pneumatic Machinery.

Pneumatic Machinery for Loading and Discharging Grain Cargoes. Frederic Eliot-Duckham. Read at meeting of Inst. of Naval Arch'ts., London. Reviews the increase in trade and the changed conditions making improvements important, and gives illustrated description of pneumatic elevators now in successful operation. 1700 w. Engr, Lond—April 8, 1898. No. 19650 A.

Refrigeration.

Mechanical Refrigeration by Use of Compressed Air. Leicester Allen. A clear explanation of the mode of cooling by compressed air, and the cause of failure from wrong application. Covers the entire cycle of operations and changes in the process. 3000 w. Am Mach—April 21, 1898. No. 19689.

ENGINES AND MOTORS.

Balancing.

The Balancing of Engines. James Whitcher. Read before the Manchester (Eng.) Assn. of Engs. Treats the subject in an explanatory manner, showing on what the science of balancing is founded, discussing the effect of the balancing effort upon the bearing pressures, the balancing proper of engines, &c. 4000 w. Ind & Ir—March 25, 1898. Serial. 1st part. No. 19394 A.

Breakdown.

Accident to a Steam Engine. (Unfall an einer Dampfmaschine.) O. Meyerhoff. A description with illustrations, of the breakdown of a tandem Corliss engine at Widzew near Lodz, Poland. The intermediate piston rod broke, causing much damage; the constructive defects which led to the accident are discussed. 1500 w. Zeitschr d Ver Deutscher Ing—April 9, 1898. No. 19831 D.

Calorimeters.

Steam Calorimeters. A. H. Eldredge. Treats of their construction, value and use to the engineer. Ill. 1600 w. Mach, N. Y.—April, 1898. No. 19355.

Engine Tests.

Test of Grosvenordale Compound Engine With and Without Jackets. G. H. Barrus. An elaborate article showing action of jackets. 1500 w. Eng Rec—April 16, 1898. No. 19625.

Furnace Gas.

The Application of Blast Furnace Gases for Direct Power Generation. (Verwendung der Hochofengase Zur Unmittelbaren Krafterzeugung.) F. W. Lürmann. A paper presented at the Düsseldorf convention of the *Verein Deutscher Eisenhüttenleute* with discussion. The practical difficulties are dealt with, and points from the limited experience available are given. 10000 w. Stahl und Eisen—March 15, 1898. No. 19853 D.

The Utilization of Blast Furnace Gas in Gas Engines. F. W. Luermann. Condensed translation of a paper read before the general meeting of the Verein Deutscher Eisenhuettenleute. Part first deals with the efficiency of the gas engine, and the dust contained in furnace gases. 2500 w. Am Mfr & Ir Wld—April 8, 1898. Serial. 1st part. No. 19508.

Gas Engines.

Combustion Motors with High Compression. (Moteurs à Combustion et Haute Compression.) A paper by M. Wilz, discussing especially the theories of Diesel, in connection with the high compression used with the Diesel motor. 1000

w. Comptes Rendus—March 28, 1898. No. 19823 D.

Critical Notes on the Theory and Construction of Recent Gas Engines. (Kritische Bemerkungen über die Theorie und Bauart der Neueren Gaskraftmaschinen.) G. Wellner. A review of the theories advanced by Diesel, with especial regard to the compression of the gas and air separately. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—March 25, 1898. No. 19842 B.

Gas and Oil Engines. Thomas L. Wilkinson. Read before the Colorado Scientific Soc. in Denver. Part first considers the original Otto gas engine, comparing it with the modern Otto, noting the advancement. 2400 w. Am Mfr & Ir Wld—April 1, 1898. Serial. 1st part. No. 19405.

Governor.

Governor with Electric Brake. (Régulateur à Frein Electrique.) Rieter's improved governor is especially adapted for use with hydraulic motors, and utilizes the retarding action of an electric current upon a revolving mass of iron to assist in the regulation of the speed. 1000 w. Le Génie Civil—March 19, 1898. No. 19802 D.

Shaft Governor with Relieved Connections. (Achsenregler mit Entlasteten Gelenken.) O. Franiek. An improved shaft governor in which knife-edge bearings are used, in order to avoid the disturbing influence of friction in the pin connections. 1200 w. Zeitschr d Ver Deutscher Ing—March 19, 1898. No. 19826 D.

Steam Economy.

The Economical Use of Steam in Non-Condensing Engines. James B. Stanwood. A discussion of the conditions under which the use of a fixed point of cut-off and throttling governor may be preferable to automatic cut-off. 3500 w. Engineering Magazine—May, 1898. No. 19935 B.

Steam Engines.

An Historical Chapter on the Steam Engine. Traces from B. C. down to the present time, in chronological order, the different stages the steam engine has passed through. Taken from a treatise on "Smokeless Heat" issued by the General Engineering Co. of Toronto. 1400 w. Can Elec News—April, 1898. No. 19507.

Steam Jackets.

The Efficiency of Steam Jackets. An editorial claiming that jacketing is not worth its expense. 700 w. Eng Rec—April 16, 1898. No. 19621.

Wave Motor.

Successful Tests of the Wright Wave Motor. Illustrates and describes this motor and its working, giving results of tests. 1000 w. Elec Eng, N. Y.—April 7, 1898. No. 19429.

POWER AND TRANSMISSION.

Cables.

Improvements in the Application of Cables for Power Transmission and Hoisting. (Neueres auf dem Gebiete der Herstellung und Anwendung von Seilen für Kraftübertragungen und Hebezeuge.) Dr. K. Keller. Mainly devoted to the most efficient forms of grooves for sheaves, and methods of twisting cables. 4000 w. Zeitschr d Ver Deutscher Ing—April 2, 1898. No. 19828 D.

Ice Handling.

The Use of an Overhead Cableway for Operating the Glacier of Casset. (Emploi des Cables Aériens pour l'Exploitation du Glacier du Casset.) A. Dumas. Describes the method and mechanism used for the purpose of quarrying and conveying glacier ice to Paris for domestic use. 2000 w. 1 plate. Le Génie Civil—March 26, 1898. No. 19803 D.

Power Plant.

A Water Power Plant of the Jordan River, Utah. W. P. Hardesty. Brief description of an important plant in process of construction, 22 miles south of Salt Lake City. 500 w. Eng News—April 28, 1898. No. 19795.

The Dolgeville (N. Y.) Water-Power Electric Light and Power Plant. E. A. Grissinger. Deals with the organization and the technical details relating to the installation. Ill. 3400 w. Am Elect'n—April, 1898. No. 19447.

The Economical Arrangement of Hydraulic Power Plants. Walter Ferris. An outline of the points of economy, and waste in the design of hydraulic machinery. Ill. 2200 w. Am Mach—April 21, 1898. No. 19690.

See Elecrical Engineering, Power.

Pulley.

The All-Wrought Steel Pulley. Report of the Franklin Inst., through its committee on Science and Arts, on the invention of Thomas Corscaden, of Philadelphia. Ill. 700 w. Jour Fr Inst—April, 1898. No. 19441 D.

SHOP AND FOUNDRY.

Bell Founding.

English Bell Founding. Brief interesting review of the bell-founders' art in England. 600 w. Arch, Lond—April 15, 1898. No. 19768 A.

Boring Mill.

A Machine Tool of the Last Century. W. S. Durfee. Describes a mill for boring gun barrels, found in a work published in 1791. Ill. 1600 w. Am Mach—April 28, 1898. No. 19930.

Castings.

A Pattern for a Crane Centre. Joseph Horner. General remarks on heavy castings in crane work, with detailed description of the pattern work involved. Ill. 2500 w. Mech Wld—April 15, 1898. No. 19760 A.

Feeding Castings. R. D. Moore. The writer's experience in feeding with criticism of work examined. 1200 w. Foundry—April, 1898. No. 19609.

Notes on Iron Founding. (Aus der Giesserei.) A. Ledebur. A discussion of the influence of the method of casting on the strength of cast iron, with comparisons of German and American data. 3000 w. Stahl und Eisen—March 1, 1898. No. 19851 D.

Some Suggestions for Producing Straight Castings. J. W. Du Bois. Brief discussion of what should be done to keep a casting straight. 1100 w. Foundry—April, 1898. No. 19610.

Chimneys.

See Architecture and Building, Miscellany.

Cranes.

Electric Cranes. J. G. Statter. Abstract of paper before the Northern Society of Electrical Engineers. Discussing the best forms of motors for use on cranes, especially in view of the frequent starting and stopping. Switchless cranes are described, in which the control is effected by changing the position of the brushes. 2000 w. Elec Engr, Lond—April 8, 1898. No. 19667 A.

The Hydraulic Cranes at the Port of Dunkirk. (Grues Hydrauliques du Port de Dunkerque.) Illustrated description of travelling hydraulic cranes, with details of hoisting mechanism and plan of the hydraulic installation. Radial cranes are mounted on bridge gantries travelling on tracks along the quay walls. 1800 w. 1 plate. La Revue Technique—April 10, 1898. No. 19816 D.

Dies.

Screw Testing and Die Making. Illustrated description of tools the writer has seen and used. 1200 w. Am Mach—April 28, 1898. No. 19931.

Dividing Wheel.

Mechanically Originating a Dividing Wheel. John Randol. Describes a method devised chiefly by Mr. Champion, of the Newton Machine Tool Works, of Philadelphia, which the writer thinks will produce almost perfectly divided index wheels. Ill. 1600 w. Am Mach—April 28, 1898. No. 19928.

Electrical Works.

Messrs. Mavor and Coulson's Electrical Engineering Works. Illustrated description of these works, in Glasgow, for the production of electrical machinery. 1800 w. Elect'n, Lond—March 25, 1898. No. 19397 A.

Engine Shop.

Sulzer Brothers—A Swiss Engine Shop. Gives a brief outline of the principles of Swiss legislation, and the conditions affecting manufacturing, with illustrated description of this fine machinery building establishment. 4000 w. Am Mach—April 7, 1898. No. 19434.

Forgings.

Fatigue of Metal in Wrought Iron and Steel Forgings. H. F. J. Porter. Part first considers some of the defects in steel forgings which have caused their failure in the past and have tended to prevent their general use, showing that they were due to faulty methods of manufacture. Ill. 4800 w. Jour Fr Inst—April, 1898. Serial. 1st part. No. 19439 D.

The Operation of Forging Presses. (Ueber den Betrieb von Schmiedepressen.) R. M. Daelen. A discussion of the power required to drive forging presses. Indicator diagrams are given showing the power developed by the engine for various conditions of the work. 1500 w. Stahl und Eisen—April 1, 1898. No. 19856 D.

Foundry Iron.

Furnace Facts About Foundry Iron. Charles W. Friend. Read before the Pittsburg Foundrymen's Assn. Facts about foundry iron as seen from a manufacturer's standpoint, with tests made to determine iron of suitable analysis for various kinds of work. 1200 w. Ir Trd Rev—March 31, 1898. No. 19331.

Jig Making.

An Example of Jig Making. A. H. Cleaves. Illustrated description of a good example of jig construction designed by Fred Smith, manager of the Chicago Manufacturing Optical Co. 400 w. Am Mach—April 7, 1898. No. 19435.

Melting.

Some of the Advantages of the Positive Pressure Blower Over the Fan for Melting Iron. J. A. Caldwell. From a paper read at meeting of the New England Foundrymen's Assn. The positive pressure of the blast, and its good results are set forth. 1700 w. Foundry—April, 1898. No. 19611.

Molding.

Molding Connecting Rod Brasses. C. Vickers. Suggestions, description of method, and remarks on shrinkage. Ill. 1100 w. Am Mach—April 28, 1898. No. 19926.

Patterns.

Storing and Indexing Patterns. Oscar E. Perrigo. Describes the system in use by the writer, giving many suggestions for the storing of patterns of various sizes, the materials to be used, &c. 900 w. Am Mach—April 14, 1898. No. 19584.

Rammer.

A Portable Pneumatic Rammer. George C. Mattock. Read before the Foundrymen's Assn. Illustrated description of a portable pneumatic rammer designed by Joseph C. Cramp. 2000 w. Ir Trd Rev—April 14, 1898. No. 19593.

Reboring.

Reboring a Steam Cylinder. Charles A. Hague. An accident made it necessary to rebore a cylinder, and an account of the arrangements is given by which the work was accomplished in a single day. 1000 w. Am Mach—April 28, 1898. No. 19932.

Riveting.

Riveting by Electricity. F. von Kodolitsch. Read at meeting of Inst. of Naval Archt's., London. On the superiority of the electric system in the writer's opinion, with an illustrated description of a machine. 700 w. Engr, Lond—April 1, 1898. No. 19539 A.

Shop Costs.

An Effective System of Finding and Keeping Shop Costs. Henry Roland. Showing the practical application of the collective job ticket system as it is applied in a drop forging works with details from daily experience. 3500 w. Engineering Magazine—May, 1898. No. 19938 B.

Shop Power.

Electric Distribution of Shop Power. George Gibbs. Read before the N. Y. RR. Club. Describes different types on the market and comments on their suitability for railway shop work, with suggestions on the manner of laying out the system. Also discussion. 11500 w. N Y R R Club—March 17, 1898. No. 19677 D.

Shop Reconstruction.

Cost of Remodeling an Old Factory. W. S. Rogers. An account of a plant before and after reconstruction, with report of cost, and other matters of interest. Ill. 2200 w. Mach, N. Y.—April, 1898. No. 19353.

Staybolts.

Recent Improvements in Making Staybolts. Shows the method of punching test holes, and the method devised and developed by James Hartness for cutting the threads accurately in a turret lathe by means of dies. Ill. 1500 w. Am Eng & R R Jour—April, 1898. No. 19339 C.

Swedish Machinery.

Swedish Wood Working Machinery. John E. Sweet. Illustrations with descriptions of a resawing machine and a wood planing machine of unusual excellence. 1000 w. Am Mach—April 14, 1898. No. 19583.

Test Bars.

Comparative Value of Test Bars. Thomas D. West. A criticism of statements in paper of Herbert E. Field, published in the Feb. number of this paper. 2000 w. Mach, N. Y.—April, 1898. No. 19354.

Testing Tools.

Testing Machine Tools with the Micrometer Caliper. Theodore H. Miller. Presents a few of the many ways that the micrometer caliper can be applied for the purpose of making tests of the accuracy of machine tools. Ill. 1200 w. Am Mach—April 21, 1898. No. 19688.

Tool Works.

The Works of the American Tool Works Company. Illustrated description of these works, the departments, methods, packing, show cabinets, and processes. 3000 w. Ir Age—April 21, 1898. No. 19684.

MISCELLANY.

Automobiles.

Motor-Car Machinery. T. Clarkson. Excerpt of paper read before the Automobile Club, London. Discusses the propelling machinery. 1100 w. Automotor Jour—April, 1898. No. 19902 A.

The Motor Carriage. Illustrated description of motor carriages of the past and present, with an account of the work of W. J. Still, and of a service to be opened between the City of Toronto and Richmond Hill. 3000 w. Can Eng—April, 1898. No. 19573.

Columns.

See Architecture and Building, Miscellany.

Education.

An Engineering Education. A discussion of what lines should be laid down as a guide for training an engineer. 4000 w. Jour W Soc of Engs—Feb., 1898. No. 19527 D.

Fly Wheels.

Fly Wheel Explosions. (Ueber Schwungradexplosionen.) J. Goebel. An investigation into the stresses in the arms and runs of flywheels due both to rotation and to methods of construction, and a mathematical discussion of the action of the forces causing explosions. 5000 w. Zeitschr d Ver Deutscher Ing—March 26, 1898. No. 19327 D.

Grain Tanks.

Lateral and Vertical Stresses in Grain Tanks. Max Toltz. Mathematical study, with report of experiments made by Mr. Prante, of Hamburg, Germany. 1000 w. Eng News—April 7, 1898. No. 19462.

Hydraulic Ram.

Tests of a Rife Hydraulic Ram. I. Efficiency and Capacity Test and Comparison of the Effect of "Statical" and "Sliding" Head in Driving the Ram. Theo. W. Johnson and Arthur J. Wood. II. Efficiency Test under High Driving Heads and the Determination of the Lowest Ratio between the Driving and Pumping Heads. A. Beutler, Jr., P. J. Brune and Thomas J. Main. Illustrated detailed description of tests made. 5000 w. Stevens Ind—April, 1898. No. 19714 D.

Mail Vans.

The Performances of the Post Office Motor Mail Vans. Reviews the trials that have been made with automobiles for Post Office use and the degree of success attained and makes a few remarks concerning their adoption. 900 w. Automotor Jour—April 16, 1898. No. 19901 A.

Needles.

The Manufacture of Needles. Illustrated description of the work as carried on at the most important factory in the world—that of H. Milward and Sons, Ltd., in Redditch, England. 3800 w. Engr, Lond—April 1, 1898. No. 19537 A.

Nozzles.

Investigations into the Discharge of Air from Conical Diverging Nozzles. (Versuche über das Ausströmen von Luft durch Konisch Divergente Rohre.) A. Fliegner. A general examination of the theory, with diagrams based upon experimental researches, with especial reference to the nozzles of the de Laval steam turbine. Three articles. 8000 w. Schweizerische Bauzeitung—March 5, 12, 19, 1898. No. 19834 each B.

Pumps.

Auxiliary Suction Pumps. Describes a centrifugal pump driven by Pelton wheel used to lift water when the suction of main pumps has increased beyond practicable limits. 500 w. Eng Rec—April 2, 1898. No. 19408.

Recorder.

A Portable Recorder for Tests of Metals. Gustavus Charles Henning. Illustrated description of instrument designed by the writer, with report of tests. 3000 w. Stevens Ind—Jan., 1898. No. 19401 D.

Rubber Goods.

Mechanical Rubber Goods. C. Wadsworth, Jr. Illustrated description of plant and some of the products of the Manhattan Rubber Mfg. Co. whose factory is located at Passaic, N. J. 1800 w. Engr, N. Y.—April 15, 1898. No. 19614.

Smoke.

Practical Smoke Prevention. W. Nicholson. Suggestions from a smoke inspector of large experience. 1800 w. San Rec—April 15, 1898. Serial. 1st part. No. 19764 A.

Testing Bureau.

Report of the Work of the Royal Technical Testing Bureau for the year 1896-1897. (Bericht über die Thätigkeit der Königlichen Technischen Versuchsanstalten in Etatsjahre 1896-1897.) The official report of this important Government bureau, with detailed classification of the number and character of tests. 7500 w. Mitt aus den Kgl Tech Versuchsansalt—Part 6, 1897. No. 19864 F.

Tile Works.

The New Tile Factory at Eichicht, Bohemia. (Nouvelle Tuilerie Mécanique d'Eichicht.) A general description showing the arrangement and operation of machinery for the production of tiles with a minimum of manual labor. 1000 w. Le Génie Civil—April 2, 1898. No. 19810 D.

Tires.

The Influence of Width of Tire on Draft of Wagons. Gives the results of a series of experiments at the University of the State of Missouri, to determine the influence of the width of tire upon the draft of wagons. 1200 w. Eng News—March 31, 1898. No. 19321.

Wheel.

A New Form of Wheel for Vehicles. (Une Nouvelle Roue de Véhicule.) D. Bellet. The built-up metallic hub receives the wooden spokes upon rounded bearings in such a manner as to distribute the pressure uniformly; an improved method of lubrication is provided. 1200 w. La Revue Technique—April 10, 1898. No. 19818 D.

MILITARY ENGINEERING.

Armament.

The Armament of Battle Ships. (Die Bewaffnung von Kriegsschiffen.) Von Neudeck. The first of an important series of articles on the artillery and armament of modern battleships, including guns, carriages, turrets, and mechanism of manipulation. 4500 w. Zeitschr d ver Deutscher Ing—April 2, 1898. No. 19830 D.

Arsenals.

Busy Times at Arsenals. The rush of preparing materials for war is described, with illustrations of the U. S. Arsenal at Watervliet, N. Y. 1000 w. Harper's Wk—April 9, 1898. No. 19456.

Battleships.

Defenders of Our Seacoast. Illustrates and describes many vessels of the United States navy, and the launching of the "Kentucky" and "Kearsarge." 6000 w. Engr, N. Y.—April 1, 1898. No. 19344.

Three Great Battle-Ships. Robert G. Skerrett. Brief description with illustration of the sister ships Illinois, Alabama, and Wisconsin. 700 w. Harper's Wk—April 16, 1898. No. 19579.

Breech Mechanism.

The Dashiell Breech Mechanism. An illustrated description of this mechanism as applied to a 4-inch breech-loading rifle. 900 w. Sci Am—April 30, 1898. No. 19786.

British Navy.

The Latest Reconstruction of the Navy. W. H. White. Considers the magnitude of the work that has been done, and some of its salient features. 6500 w. Nineteenth Cent—April, 1898—No. 19606 D.

British Ships.

British Ships in Foreign Navies. Archibald S. Hurd. Information concerning the warships being built by the British Government, for other Powers, with details showing the number and character of those that have been designed, built, armed and fitted out, and remarks on the strange policy of arming the world against themselves and lending officers to train foreigners in the use of these weapons. 2300 w. Nineteenth Cent—April, 1898. No. 19607 D.

Compressed Air.

High Range Compressed Air for War Ships. Frank Richards. Explains a modification of the compressed-air system, which is an improvement on the present practice. 1000 w. Am Mach—March 31, 1898. No. 19312.

Cruisers.

Purchase of Brazilian Cruisers Amazonas and Abrouill by the United States. Description of these new vessels, with data regarding their armament, and comparison with U. S. S. Cincinnati. Also descriptions of other vessels, the subject of negotiations, auxiliary ships, U. S. shipbuilding, new dock facilities, etc. Ill. 4500 w. Marine Engng—April, 1898. No. 19509 C.

Recent Trials of the Cruiser "Diadem." Sir John Durston. Read before the Inst. of Naval Arch'ts, London. An account of the contract and experimental trials with tables of mean results. Ill. 3300 w. Engng—April 8, 1898. No. 19646 A.

The New Armored Cruisers. Describes the new vessels recently ordered by England. 1200 w. Engng—March 25, 1898. No. 19384 A.

The New Second Class Cruiser "Hermes." Compares the vessel with some earlier second-class cruisers, showing the progress, and describes the important features. 1500 w. Engng—April 15, 1898. No. 19745 A.

The Powerful and Her Critics. Editorial on the unjust criticisms of this vessel, claiming that they are not justified by facts. 2000 w. Engr, Lond—March 25, 1898. No. 19390 A.

Destroyers.

The Development of the Torpedo Boat Destroyer. John Platt. A very complete and fully illustrated account of the latest develop-

ments in the construction of the torpedo boat destroyer, as distinguished from the smaller and weaker torpedo boats. 3000 w. Engineering Magazine—May, 1898. No. 19933 B.

Electric Equipment.

The Electric Equipment of the Cruiser "Chitose." G. W. Dickie. The equipment embraces not only a complete system of lighting, but also power hoists for the ammunition of both the main and secondary batteries, search lights, fans for ventilation, etc. Ill. 1800 w. Elec Wld—April 9, 1898. No. 19452.

The Present Uses and Future Prospects of Electricity on Board Ship. E. George Tidd. Read before the Glasgow Students' Assn. of the Inst. of Civ. Engs. Part first discusses position of the plant, type of plant, types of engines, etc. 2000 w. Elec Eng, Lond—April 8, 1898. Serial. 1st part. No. 19666 A.

Electricity on Merchant Vessels. (Die Electricität au Bord von Handelsdampfern.) C. Arldt. A general discussion of the use of electricity on merchant vessels for lighting, power, and transmission of signals. Two articles. 5000 w. Der Electro-Techniker—March 15, 31, 1898. No. 19879 each B.

Applications of Electricity on a Modern Warship. George H. Shepard. Discusses the wastefulness of auxiliary machinery, and the possible substitution of a central electric power plant, and shows that at the present time conditions of weight, bulk, and cost render such a system impracticable. 3500 w. Engineering Magazine—May, 1898. No. 19941 B.

Electricity.

Electricity in Modern Warfare. Editorial on the part played by the electrical engineers and manufacturers in the preparations for war. 700 w. Elec Rev, N. Y.—April 6, 1898. No. 19427.

Gun and Armor.

A Victory for the Gun over the Armor. (Une Victoire du Canon sur la Cuirasse.) A review of the American tests of Harveyized steel armor, with especial reference to the piercing of a 10 in. plate by a Johnson projectile. 2500 w. La Revue Technique—March 25, 1898. No. 19814 D.

Mortar Batteries.

The Sandy Hook Mortar Batteries. Illustrated description of the strongest fortifications on the American continent, for the defence of New York harbor. 1500 w. Sci Am—April 16, 1898. No. 19590.

Navies Compared.

The Navies of the United States and Spain—A Comparison. Illustrations of the Spanish and American war-ships, with remarks on their strength and importance. 2200 w. Sci Am—April 2, 1898. No. 19326.

Spanish Navy.

Spain's Naval Strength. A. K. Fiske. Information compiled mainly from a "List of the Battle-ships, Cruisers and Torpedo-boats of the Spanish Navy" prepared in the Military Information Division of the Adjutant-General's Office at Washington. Ill. 2200 w. Harper's Wk—April 16, 1898. No. 19578.

Squadrons.

Analysis of Squadrons of Spain and United States. Diagrams denoting the existing conditions of the two groups of battleships, armored cruisers and protected vessels, with remarks. Ill. 1000 w. Engr, Lond—April 15, 1898. No. 19751 A.

Submarine Boats.

Submarine Torpedo-Boats: Their Influence on Torpedo Boat Architecture and Value in Warfare. William H. Jaques. Read at meeting of the Inst. of Naval Arch'ts. General remarks on needed improvements, with descriptions of the "Plunger" and the "Holland." Ill. 3000 w. Ind & Ir—April 7, 1898. No. 19658 A.

Successful Trials of the Holland Submarine Boat. Illustrated description of this interesting vessel, with report of tests, and editorial. 2300 w. Sci Am—April 9, 1898. No. 19453.

Torpedo.

A New Automobile Torpedo. (Nouvelle Torpille Automobile.) H. Noalhat. A detailed mechanical description of the Howell torpedo, as made by the French Hotchkiss company. 3000 w. Le Génie Civil—March 26, 1898. No. 19805 D.

MINING AND METALLURGY.

COAL AND COKE.

Alabama Coal.

Alabama Coal in By-product Ovens. William B. Phillips. An account of the testing of 54,000 lbs. of this coal, with the view of ascertaining to what extent it would lend itself to the recovery of by-products and the production of coke suitable for use in the blast furnace. 1400 w. Am Mfr & Ir Wld—April 1, 1898. No. 19406.

Anthracite.

A Successful Experiment in Anthracite Mining. William Tate. A method of obtaining 90 per cent. of the coal in pitching veins. Report of a visit to the Richards mine of the Union Coal Co., near Mount Carmel, Pa., and an account of the experiences from which the method originated. Ill. 2000 w. Mines & Min—April, 1898. No. 19518 C.

China.

The Coal and Iron Deposits of Eastern China. Audrel Kurita. These deposits, which have been examined by the writer, are of great importance and the exclusive right to work them has been granted to an English syndicate. The coal field is the largest known in the world. 1000 w. Eng & Min Jour—April 23, 1898. No. 19711.

Coal.

Coal Is King. I. The Advantage of Eng-

land and the United States in the World's Commerce. Edward Atkinson. II. The Supply of Anthracite Coal in Pennsylvania. Edward W. Parker. The advantages due to the predominance of coal, iron and steel. 1800 w. Century Mag—April, 1898. No. 19335 D.

Coal Analysis.

The Analysis of Coal. Durand Woodman. Considers the methods employed, showing that the choice depends on the purpose for which the coal is to be used. 2000 w. Stevens Ind—Jan., 1898. Serial. 1st part. No. 19400 D.

Colliery Village.

A Pennsylvania Colliery Village. I. A Polyglot Community, by Henry Edward Rood II. An Artist's Impressions of the Colliery Region. Jay Hambridge. Descriptive. Ill. 9500 w. Century Mag—April, 1898. No. 19334 D.

Gobbin Quarry.

Gobbin Quarry and Railway at the Saint-Etienne Collieries. M. Perrin. From a communication to the Société de l'Industrie Minérale. Describes the arrangements made to provide a supply of gob material in all weathers, and to deliver it to all the points needed. Ill. 3000 w. Col Guard—April 7, 1898. No. 19651 A.

Haulage.

Underground Haulage. Ernest H. Thomas. From the Proceedings of the South Wales Inst. of Engs. A paper for which a prize was awarded in competition for the Lewis prizes. The subject is confined to haulage in coal mines of medium inclination. Ill. 5000 w. Col Guard—March 25, 1898. Serial. 1st part. No. 19382 A.

India.

Warora Colliery. Report of this colliery for the past year; the output, accidents, &c. 1000 w. Ind Engng—March 26, 1898. No. 19905 D.

Peat.

The Distillation of Peat in a closed Retort. (La Tourbe et sa Distillation en Vas Clos.) Fr. Miron. An investigation of the composition of the various kinds of turf fuel found in France, and the products resulting from destructive distillation. 1200 w. La Revue Technique—April 10, 1898. No. 19817 D.

Pneumatophor.

The Pneumatophor and Its Value for Saving Life After Colliery Explosions. Richard Cremer. Read before a recent meeting at Sheffield, Eng. Presents the advantages of this apparatus, describes it, and its manipulation. 1500 w. Ir & Coal Trds Rev—April 8, 1898. No. 19657 A.

Washing.

Washing Alabama Coal. A description of some of the results obtained by washing coal for coke making. The advantages gained are indicated and also the kinds of coal with which the different appliances give the most favorable results. 2300 w. Mines & Min—April, 1898. No. 19516 C.

COPPER.

Analysis.

Improved Methods of Analysis. Titus Ulke. Gives methods for the determination of arsenic and antimony in electrolytic copper, of copper in slimes, and of copper and nickel in ores and furnace products. 1300 w. Eng & Min Jour—April 9, 1898. No. 19478.

Copper Extraction.

The Extraction of Copper from Residues of Pyrites Burners. R. Helmhacker. Describes the Hoepfner method, this being the most used process, and gives particulars of the plant of the Vitkovice Copper Extracting and Electrolytic Works in Austria. 1400 w. Min & Sci Pr—April 16, 1898. No. 19708.

Copper Wire.

The Biography of a Piece of Copper Wire. C. T. Gage. An outline of the various processes through which the bare and insulated copper wire passes from its crude material to some of the forms in which it becomes useful. 2500 w. Elec Wld—April 2, 1898. No. 19333.

GOLD AND SILVER.

British Columbia.

Gold-Bearing Reefs and Placers of Northern British Columbia. William Hamilton Merritt. Notes on the general character of the placers and quartz reefs, and the general character of the ores. Ill. 3800 w. Can Min Rev—March, 1898. No. 19372 C.

Notes on Mining on the Coast of B. C. and the Adjacent Islands. G. F. Moncton. Read at meeting of the Fed. Can. Min. Inst. Information relating to this district. 1500 w. Can Min Rev—March, 1898. No. 19370 C.

Gold Fields.

Notes on the Michipicoton Gold Field. A. W. Willmott. Read at meeting of the Fed. Can. Min. Inst. Facts gathered from a brief geological examination of this district. 700 w. Can Min Rev—March, 1898. No. 19371 C.

The Golden Heart of the Sierra Madre. H. D. Slater. Illustrated description of the new gold fields of the Mexican Sierras, with some account of the country and the way to reach the mines. 2000 w. Am Rev of Revs—April, 1898. No. 19350 C.

The Minerals Which Accompany Gold, and Their Bearing upon the Richness of Ore Deposits. T. A. Rickard. Abstract of a paper read before the Inst. of Min. and Met, London. Discusses this question of indicative minerals and how far they determine the value of the deposit, giving examples from the writer's experience. 4000 w. Eng & Min Jour—April 23, 1898. No. 19712.

Kalgoorlie.

Kalgoorlie, Western Australia, and its Surroundings. George J. Bancroft. Location, manner of reaching and climatic conditions of Kalgoorlie, with information of the deposits and ores. Ill. 3300 w. Trans Am Inst of Min Engs—Feb., 1898. No. 19523 D.

Kalgoorlie, Western Australia. T. A. Rickard. A general account of this region and the writer's impressions. 1700 w. Eng & Min Jour—April 16, 1898. No. 19632.

Klondike.

The New Arctic El Dorado. Henry Wysham Lanier. An account of the gold-rush to this region, and of the routes, country, prospects, etc. Ill. 3000 w. Chau—May, 1898. No. 19913 C.

Milling.

Some Modern Forms of Milling Machinery. Frederick T. Snyder. Describes machinery designed to handle the gold ores of the Lake of the Woods, many of which are of low grade, but contain streaks of high value. The principal features were improvements in the detail of existing methods. 2500 w. Can Eng—April, 1898. No. 19570.

Mixed Sulphides.

The Treatment of Complex Lead, Zinc, Silver, Sulphide Ores. O. J. Steinhart. A brief account of past work, with special reference to its most recent developments. 3000 w. Ind & Ir—March 24, 1898. Serial. 1st part. No. 19393 A.

Oregon Mine.

The Columbia Placer, Oregon. James W. Abbott. Describes the manner of working. 2000 w. Eng & Min Jour—April 9, 1898. No. 19479.

Placer Mining.

A New Method of Placer Mining for Gold. F. B. Knight. A device for excavating and handling large quantities of material at low cost, and means by which a gold-saving flume can be used and the tailings disposed of when the surface has but a moderate degree of fall. Ill. 2900 w. Mines & Min—April, 1898. No. 19514 C.

Prospecting.

Prospecting Experiences. Arthur Lakes. General thoughts upon prospecting, with descriptions of the peculiarities of several promising but undeveloped economic deposits of minerals which are valuable though not so commonly sought after. Ill. 4000 w. Mines & Min—April, 1898. No. 19517 C.

Roasting.

Roasting Gold Ores. H. Van F. Furman. Discussing the chemistry of the process and the ores to which it should be applied, describing the different methods. Ill. 2200 w. Mines & Min—April, 1898. Serial. 1st part. No. 19519 C.

Russia.

The Kotchkar Gold-Mines, Ural Mountains, Russia. H. B. C. Nitze, and C. W. Purington. Deals especially with the deposit known as the Ouspensky mine. 2800 w. Trans Am Inst of Min Engs—Feb., 1898. No. 19528 D.

Slimes.

The Economic Treatment of Slimes. Charles Butters. Valedictory address of the president of the Chem & Met. Soc. of S. Africa. States the general features of the slimes problem, and the work of the writer in this field. Also discussion. 9000 w. Jour of Chem & Met Soc of S Africa—Feb., 1898. No. 19619 E.

Tailings.

The Tailings Plant of the Montana Mining Company, Limited. C. W. Merrill. Illustrated description of the plant, with method of operating. 800 w. Eng & Min Jour—April 16, 1898. No. 19630.

Witwatersrand.

Mining the Gold Ores of the Witwatersrand. H. H. Webb and Pope Yeatman. Especially devoted to the mechanical details of the equipment of the South African mines, with descriptions of buildings, machinery and mining appliances. Many illustrations. 3500 w. Engineering Magazine—May, 1898. No. 19940 B.

IRON AND STEEL.

American Iron.

Great Britain's Need of American Iron. From the *London Statist*. Gives the comparative outputs of the United Kingdom, United States and Germany for each of the last seven years, and discusses the changed conditions of the iron market. 700 w. Ir Trd Rev—March 31, 1898. No. 19330.

American Practice.

Notes on American Iron and Steel Practice. Archibald P. Head. Read before the South Staffordshire Inst. of Iron & Steel Works' Managers. Notes taken during eight visits to the United States in the last eight years. Ill. 3500 w. Engng—March 25, 1898. Serial. 1st part. No. 19387 A.

Bessemer.

Sir Henry Bessemer and His Work. Reviews his career. 2000 w. Jour of Gas Lgt—March 22, 1898. No. 19322 A.

Brown Ore.

The Brown Ore Deposits Near Leeds, Alabama. William B. Phillips. Report from personal observations of the writer, who holds that the district will become a notable producer. Ill. 2000 w. Eng & Min Jour—April 23, 1898. No. 19709.

Cast Steel.

The Progress of Open-Hearth Cast Steel in Machine Construction. A. W. Discusses the improvement in methods and the investigations needed to remove the uncertainty as to interior integrity, and shows the excellent character of the open hearth cast steel. Ill. 1600 w. Ir Age—March 31, 1898. No. 19328.

Concentration.

The Magnetic Concentration of the Folkmar Red Iron Ore. (Magnetische Concentration der Folkmarer Rotheisensteine.) Stefan Farbaky. A discussion of the possibility of concentrating this large body of ore by the Wetherill process, with estimate of cost, &c. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 26, 1898. No. 19875 B.

China.

The Iron Ore Beds in the Tayeh District, Hupeh Province, China. G. Leinung. Abstract translation from *Stahl und Eisen*. Report concerning the red iron ore and magnetic iron deposit, and the hematite ore deposits. 2000

w. Ir & Coal Trds Rev—April 15, 1898. No. 16756 A.

The Iron Ore Deposits of the Tayeh District, China. G. Leinung. Condensed translation. Concerning the importance of the district and the principal ore occurrences. 1200 w. Am Mfr & Ir Wld—April 1, 1898. No. 19404.

The Iron Ore Deposits in the Tayeh District, Province of Hupeh, China. (Eisenerzvorkommen im Tayeh-Bezirk, Prov. Hupeh, China.) G. Leinung. A general review of the geological and mineralogical conditions of this important deposit of iron ore, and an account of the present workings. 5000 w. Stahl und Eisen—March 1, 1898. No. 19852 D.

Cuba Iron.

Bessemer Hematite from the Island of Cuba. Details of the iron-ore mines of Cuba, with illustrations, and the low cost of production which makes it possible to ship it to British and European markets. 700 w. Ir & Coal Trds Rev—April 8, 1898. No. 19655 A.

Cupola Design.

Some Variations in Cupola Design. Part first considers cupolas attempting to secure economy through the arrangement or shape of their tuyeres. Ill. 2000 w. Ir & Coal Trds Rev—April 15, 1898. Serial. 1st part. No. 19755 A.

Explosives.

On the Various Systems of High Explosives and the Conditions of their Economical Application to the Different Methods of Coal Working in British Collieries. F. J. Rowan. Special prize essay of Ir. & Coal Trds. Rev. Part first discusses the conditions of safety in explosives and explosives due entirely to combustion. 2000 w. Ir & Coal Trds Rev—April 8, 1898. Serial. 1st part. No. 19654 A.

Furnace.

Electrometallurgy in the Iron Industry. (Elektrometallurgisches für die Eisenindustrie.) Dr. W. Borchers. A paper before the Düsseldorf Convention of the *Verein Deutscher Eisenhüttenleute*, showing the applicability of the electric furnace to the iron industry, with numerous illustrations of special constructions. 4000 w. Stahl und Eisen—April 1, 1898. No. 19855 D.

Electro-Metallurgical Memoranda of the Iron Industry. Translation and comment by Richard Moldenke. Discusses electrical heating and the electric furnace and their application to the demands of industrial requirements. 2500 w. Ir Trd Rev—April 21, 1898. No. 19707.

Furnace Gas.

See Mechanical Engineering, Power and Transmission.

Iron Making.

New Economies in Iron Making. Herman L. Hartenstein. Describes the method of producing carbolite and its value as an illuminant, and for other uses. 2800 w. Am Mfr & Ir Wld—April 22, 1898. No. 19736.

Iron Ore.

The Lake Superior Iron Ore Region. Horace V. Winchell. Gives the facts as to the discovery and early history, with description of the mines and account of the present methods of exploiting them. Ill. 20000 w. Trans. of the Federated Inst. of Min. Engs. (England)—June 3, 1897. No. 19307 H.

Nickel Steel.

Researches on Nickel Steel. (Recherches sur les Aciers au Nickel.) C. E. Guillaume. A full account of the important investigations of Mr. Guillaume into the magnetic, thermal and physical properties of alloys of steel and nickel with details of the apparatus, and many tables and diagrams. An important paper. 12000 w. Bulletin de la Société d'Encour—March, 1898. No. 19825 G.

Norway Ores.

The Silicious Iron Ores of Northern Norway. H. T. Newbigin. Describes iron-ore deposits lying between 66° and 68° North. 1200 w. Ir & Coal Trds Rev—April 8, 1898. No. 19656 A.

Ore Transportation.

The Bessemer Road and Its Conneaut Terminals. Presents some features of the Pittsburg, Bessemer & Lake Erie route from Conneaut to Pittsburg, the harbor arrangements, and dock improvements and the importance of the road in the handling and transportation of ore. Ill. 1200 w. Ir Trd Rev—March 31, 1898. No. 19329.

Pig Iron.

Commercial Progress as Influenced by the Development of the Pig Iron Industry. John Birkinbine. Read before the Federated Canadian Mining Inst. Discusses the production of pig iron, and the reliance of the more advanced stages of manufacture upon the crude metal, as illustrated by the record made in the United States. 3000 w. Can Min Rev—March, 1898. No. 19369 C.

Need of Greater Uniformity in Pig Iron Analyses. Thomas D. West. Read by title before the Pittsburg Foundrymen's Assn. Considers the value of chemical analyses, and factors that affect the results, giving tables. 2000 w. Am Mfr & Ir Wld—April 15, 1898. No. 19635.

The Cost and the Conditions of Producing Iron and Steel in Different Countries. Part first deals with the manufacture of pig iron in Great Britain. It is proposed to show in this series of articles the true economic circumstances in which Great Britain stands. 1400 w. Ir & Coal Trds Rev—April 1, 1898. Serial. 1st part. No. 19541 A.

Will There Be a Pig Iron Famine? C. Schoenhof. Facts bearing on this subject are presented, pointing to an affirmative answer for America. 2200 w. Ir Trd Rev—April 21, 1898. No. 19706.

Semi-Steel.

What Is Semi-Steel? Alex. E. Outerbridge, Jr. Asserting that there is no such metal, and that the material so called is not a new discovery. 1600 w. R R Gaz—April 15, 1898. No. 19600.

Steel.

Acid vs. Basic Open Hearth Steel. C. E. Stafford. A communication on the relative value for structural purposes of acid and of basic open

hearth steel. 1400 w. Ir Age—April 21, 1898. No. 19685.

Steel-Plate Tests.

Tests of Basic Open-Hearth Steel Plates. T. L. Condron. Presents 46 tests, representing 19 different melts of basic open-hearth steel. 900 w. Eng News—March 31, 1898. No. 19315.

Steel Work.

Constructional Steel Work. T. C. Cunnington. Read at meeting of the Arch. Assn., London. Part first considers columns and stanchions and their fireproofing. Ill. 2500 w. Arch, Lond—April 1, 1898. Serial. 1st part. No. 19545 A.

Steel Works.

The South Works of the Illinois Steel Company. Victor Windett. A full and clear illustrated description of these works, with discussion. 8500 w. Jour W Soc of Engs—Feb., 1898. No. 19526 D.

Swedish Iron.

The Swedish Iron, Steel, Metal, and Coal Industries in 1896. Report of these industries showing the output to be the highest on record. 1600 w. Engr, Lond—April 8, 1898. No. 19647 A.

MINING.

Colombia.

Mining Districts of Colombia. Henry G. Granger and Edward B. Treville. An interesting description of the country, its mines, and methods of working. 19000 w. Trans Am Inst of Min Engs—Feb., 1898. No. 19521 D.

Deep Mines.

Deepest Mine in the World. From the *Minneapolis Journal*. Interesting particulars of the Red Jacket Shaft of the Calumet & Hecla mine. It is 4900 ft. in depth, cost over two and a half million dollars, and has required nine years of incessant labor. 900 w. W Min Wld —April 9, 1898. No. 19567.

Demurrage.

Demurrage in Relation to the Shipment of Coal and Coke. States briefly the leading principles on demurrage applicable to the subject of this article, and mentions cases that have come before the British courts, and the decisions. 3600 w. Col Guard—April 7, 1898. Serial. 1st part. No. 19652 A.

Electric Plant.

Danger from Electrical Appliances in Coal Mines. Report of the tests made in the testing gallery of the Consolidation Colliery, near Gelsenkirchen, on the dangers from the use of electrical apparatus in coal mines. Not unfavorable, but necessary to apply the ordinary precautions. 1200 w. Engng—March 25, 1898. No. 19385 A.

Polyphase Electric Light and Power Plant at the Boryslaw Mine in Galicia. (Elektrische Drehstromanlage für Kraftübertragung in Beleuchtung der Erdwachsgruben in Boryslaw, Galizien.) A. Lukaszewski. Brief description of an important mining electric plant recently installed by Ganz & Co., of Budapest. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 5, 1898. No. 19873 B.

Eustis Mine.

Notes on the Ventilation of a Deep Metal Mine as Affected by Seasonal Changes of Temperature. John E. Preston. Considers the causes of this unsatisfactory ventilation, with the means taken to better the condition, and gives a series of analyses of the underground air. Ill. 1800 w. Can Min Rev—March, 1898. No. 19373 C.

Firedamp.

Researches on the Explosion of Firedamp Mixtures by Electric Currents. H. Couriot and J. Meunier. From *Comptes Rendus*. Some facts concerning the external influences of electricity on firedamp mixtures. 800 w. Col Guard—April 1, 1898. No. 19533 A.

The Ignition of Gaseous Mixtures by the Electric Spark. (Sur l'Explosion des Melanges Grisouteux par l'Etincelle Electrique.) A paper contributed to the French Academy by MM. Couriot and Meunier discussing the conditions under which the electric spark is capable of igniting mixtures of air and firedamp in mines. 1200 w. Comptes Rendus—March 21, 1898. No. 19821 D.

Use of Electricity in Fiery Mines, Westphalia. M. Leproux, in *Annales des Mines*. The main provisions of an ordinance dealing with the distribution and supervision of ventilation, the use of explosives, and the lighting of mines, in connection with the subject named. 3600 w. Col Guard—April 1, 1898. No. 19532 A.

Haulage.

Chain Haulage System, Humboldt System. (Kettenförderung, System Humboldt.) Robert Lamprecht. An improved system for hauling mine cars on inclines by endless running chain. 1000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 5, 1898. No. 19874 B.

Mining Haulage. G. W. Westgarth. Deals with underground haulage, indicating where the greatest economy may be effected, and showing how endless haulage installations are often unsatisfactory because of a misapplication of the load. Ill. 3800 w. Col Guard—April 15 1898. Serial. 1st part. No. 19749 A.

Hydraulic Mining.

Defining Hydraulic Mining. Extracts from a letter by T. L. Ford, of San Francisco to an inquiry as to what constituted hydraulic mining. 1700 w. Min & Sci Pr—April 23, 1898. No. 19906.

Mine Working.

Mechanical Substitutes for Explosives at the Brussels Exhibition. Victor Watteyne and Armand Halleux. From a report on the plant and methods of mine working at the Brussels International Exhibition of 1897. 1800 w. Col Guard—April 15, 1898. No. 19747 A.

Mining Districts.

System in the Location of Mining Districts. Theo. F. VanWagenen. Gives map showing that the mining localities are situated along nearly parallel belts, and conclusions that may be drawn from this fact. 1000 w. Sch of Mines Quar—Jan., 1898. No. 19917 D.

Missouri District.

Lead and Zinc Mining. E. Hedburg. A brief history of the methods used in prospecting and mining in the Joplin Missouri District, describing the manner of shaft sinking and developing and giving some figures showing cost of the plants and their operation. Ill. 2500 w. Mines & Min—April, 1898. Serial. 1st part. No. 19515 C.

Pumping Engine.

Improved Underground Pumping Engines for Mines. (Neuere Unterirdische Wasserhaltungsmaschinen für Bergwerke.) B. Gerdau. Devoted especially to recent German pumping engines for underground mine work and hydraulic power transmission, with computations of efficiency. 7500 w. 2 plates. Glückauf—March 26, 1898. No. 19871 B.

Quebec.

Mining in Quebec in 1897. J. Obalski. Notes on the state of the mining industry in this province of Canada. 1200 w. Eng & Min Jour—April 2, 1898. No. 19364.

Safety-Catch.

Automatic Safety Catch and Brake for Hoists. (Bremsend Wirkende Sicherheits Fang-und Aufsetz-Vorrichtung für Förderkörbe.) An improved and simple form of safety stop for the cages of mine hoists as used in several mines in Saxony. A table is given of the efficient manner in which the device has operated in numerous cases. 2500 w. 1 plate. Glückauf—March 19, 1898. No. 19870 B.

Safety Doors.

A Simple Form of Brake Safety Door. (Einfach Konstruierter Bremsschacht Verschluss.) A brake mechanism is connected with the door opening device so that the hoisting gear cannot be operated until the door is closed. 1000 w. 1 plate. Glückauf—March 12, 1898. No. 19869 B.

Safety Lamps.

Some Notes on the Safety Lamp Problem. H. W. Halbaum. Discusses whether the incandescent lamp should entirely supersede the older type of safety lamp; and whether the use of safety lamps should be made compulsory in all mines. 4400 w. Col. Guard—March 25, 1898. Serial. 1st part. No. 19379 A.

Shafts.

Shaft Sinking. G. E. J. McMurtrie. From the *Proceedings* of the South Wales Inst. of Engs. A paper for which a prize has been awarded in competition for the Lewis prizes. Part first considers form of shafts, explosives, drills, methods of dealing with water, winding and disposal of the débris, &c. 4400 w. Serial. 1st part. No. 19653 A.

The Application of Compressed Air for Sinking the Sterkrade Shaft at the Gütehoffnungs Works. (Die Verwendung Komprimierter Luft beim Absinken des Schachtes Sterkrade der Aktiengesellschaft Gütehoffnungshütte.) With plan and section of the shaft cylinder and air-lock, and a detailed description of the work of sinking the shaft through 16 meters of quicksand. 1800 w. 1 plate. Glückauf—March 5, 1898. No. 19868 B.

Winding Engines.

Notes on Valve Gears for Winding Engines. (Einige Bemerkungen über Fördermaschinen-Steuerungen.) P. Hartmann. A comparison of the merits of poppet and slide valves for winding engines for mine use. 1800 w. Glückauf—Feb. 26, 1898. No. 19867 B.

MISCELLANY.

Bauxite.

The Bauxite Industry. W. M. Brewer. Report of this industry in Alabama and Georgia. The shipments for 1897 were about 20,000 tons. 1000 w. Eng & Min Jour—April 2, 1898. No. 19365.

Cobalt.

Cobalt at Port Macquarie, New South Wales. J. B. Jaquet. Report on the cobalt deposits, considering them well worth further attention by the mining community. 2000 w. Aust Min Stand—Feb. 17, 1898. No. 19562 B.

Concentration.

The Concentration of Ores. Robert H. Richards. Examines the methods of concentration, the preliminary machines, the final concentrators, and general details. 3300 w. Tech Quar—March, 1898. No. 19502 F.

Corundum.

Corundum Mining in North Carolina. A. M. Stone. Some of the peculiar conditions under which this mineral is found, with brief review of the methods of mining and milling. 1000 w. Eng & Min Jour—April 23, 1898. No. 19710.

India.

Mineral Production in India. Statistics concerning salt, coal, iron, and petroleum. 1800 w. Ind & East Engr—March, 1898. No. 19679 D.

Newfoundland.

The Mineral Resources of Newfoundland. J. H. Collins. Read at the Imperial Inst., London. Considers it one of the richest islands in the world, particularly as regards copper, and perhaps iron. Reports regarding various minerals. 2300 w. Col Guard—March 25, 1898. No. 19381 A.

Petroleum.

Development of the Oil Industry in the Apsheron Peninsula. Notes and data gathered in connection with a recent visit to the Russian oil-fields, especially those situated in the Apsheron peninsula, near Baku, on the Caspian Sea. Ill. 2800 w. Engr, Lond—April 8, 1898. No. 19648 A.

Russian Petroleum Trade in 1897. Statistics giving an idea of the progress made in the past year, showing that it was an active one, but that the financial results were not as satisfactory as in 1896. 4000 w. Cons Repts—April 6, 1898. No. 19442 D.

I. Some Facts Regarding Japanese Petroleum. From the Kobé *Chronicle*. II. Petroleum in China. The first article is a statement of the location and output of the oil wells in Japan. The second is the importance of having active agents to protect the American oil interests in China. 1700 w. Cons Repts—April 5, 1898. No. 19392 D.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene Gas on a Canadian Railway. Describes the installation on an express train of the Pontiac, Pacific Junction Railway Co., stating its advantages and disadvantages. 800 w. Can Eng—April, 1898. No. 19572.

Acetylene Gas Generator. Joseph H. Adams. A simple, safe and inexpensive apparatus that may be constructed at home is described and illustrated. 800 w. Sci Am—April 23, 1898. No. 19693.

Apparatus for the Production of Acetylene Gas. (Appareils de Production du Gaz Acétylène.) E. Hubon. The first of a series of articles describing and illustrating the various generators for producing acetylene gas from calcium carbid. Serial. Part I. 2000 w. Le Génie Civil—March 26, 1898. No. 19804 D.

Calcium Carbid in Ontario. From the annual report of A. Blue, Mineral Commissioner of Ontario. Information of progress made, and of apparatus of various types for its generation and control. 1800 w. Ir Age—April 7, 1898. No. 19437.

Carbid of Calcium and Acetylene. C. de Perrodil. The first of a series of articles constituting a complete translation from a work in French. Foot notes will be given bringing the subject matter up to date, and including special developments in the United States. Part first gives historical facts, and properties of the substance. 2700 w. Pro Age—April 15, 1898. Serial. 1st part. No. 19628.

The Efficiency of Acetylene Burners. A. Webber. Abstract translation of a paper reprinted in the *Journal für Gasbeleuchtung*. Experiments made to ascertain the quality of various burners, as all burners so far used smoke after a short period of use. 800 w. Jour of Gas Lgt—April 5, 1898. No. 19618 A.

Calcium Carbid.

A New Plant for the Manufacture of Calcium Carbid. John C. Temple. Illustrations and description of the new works of the Willson Ammonium Co., located on the James River, at Holcomb Rock, Virginia. 2500 w. Eng News—April 14, 1898. No. 19595.

Carbonic Oxid.

The Toxic Properties of Carbonic Oxid. N. Grehant. Experiments recently made upon absorption by the blood, describing apparatus and method, and giving results. 2000 w. Gas Wld—April 9, 1898. No. 19668 A.

Coal Gas.

The Manufacture of Coal Gas. J. G. Newbigging. Lecture delivered at Macclesfield, Eng. Abstract. Describes the process and the apparatus, and refers to other matters of interest. 1800 w. Gas Engs' Mag—April 11, 1898. No. 19774 A.

Cost.

The Cost of the More Generally Used Sources of Illumination. (Kosten der Gebrauchlichsten Lichtquellen.) An investigation of the relative cost of illumination in Germany, using various forms of gas burners, acetylene, spirit incandescent lamps, petroleum, and various electric lamps. 3500 w. Gesundheits-Ingenieur—March 15, 1898. No. 19862 B.

Discussion.

The Gaslight and Coke Company. Reply of the Chartered Company's Directors to Mr. George Livesey's "impeachment," dealing with each of the allegations and charges in their order. 13000 w. Jour Gas Lgt—April 12, 1898. No. 19740 A.

Gas Works.

Modern Gas Engineering. M. S. Greenough. Gives a description of modern gas works, and indicates how they have been modified during the past few years. Also discussion. 6300 w. Jour Assn of Eng Soc—Feb., 1898. No. 19362 C.

Holophone Globes.

The Holophone Globes, for Effecting the Better Diffusion and Distribution of Artificial Light. Report of the Franklin Inst., through its committee on Science and Arts, on the invention of Messrs. Blondel and Psaroudaki, of Paris, France. Ill. 3000 w. Jour Fr Inst—April, 1898. No. 19440 D.

Inspection.

A House to-House Inspection Wanted. Norton H. Humphreys. Comments on the universal popularity of electricity for shop window lighting, with inquiry as to the cause. Suggests canvassers, or inspectors visiting from house to house to secure business and remedy defects in lighting. 1800 w. Jour Gas Lgt—March 29, 1898. No. 19480 A.

Leakage.

Leakage in Mains and Services. J. M. Rusby. Remarks on methods of locating and correcting existing leakage, and means of avoidance. 1700 w. Gas Engs' Mag—April 11, 1898. No. 19775 A.

Municipal Gas.

Some Recent Municipal Gas History. Edward W. Bemis. Discussing the lease of the Philadelphia gas-works, for thirty years, to a private company, after fifty-six years of public ownership and operation. 4500 w. Forum—March, 1898. No. 19492 D.

Municipal Lighting.

See Electrical Engineering, Lighting.

Paris.

The Gas Supply of Paris. Edward Conner. Interesting particulars connected with the Paris supply, with account of its development. 2000 w. Plumb & Dec—April 1, 1898. No. 19613 A.

Photometry.

See Electrical Engineering, Lighting.

Purification.

The Heat Developed During Purification by Means of Weldon Mud. A computation of the temperature which may supervene from the reactions which occur during the fouling and re-

vivification of Weldon Mud. 1800 w. Jour of Gas Lgt—March 22, 1898. No. 19323 A.

The Relative Activity of Bog Oxid and Weldon Mud as Purifying Materials. Discusses the intrinsic merits of bog oxid and of Weldon mud. 2000 w. Jour of Gas Lgt—April 19, 1898. No. 19907 A.

The Work of the Scrubbers and Purifiers. Stephen Carpenter. Describes the action of the scrubbers and the manner of working, with remarks on the size of lime and oxid of iron purifiers relatively to the make of gas. 1800 w. Jour Gas Lgt—April 19, 1898. No. 19909 A.

Street Mains.

Street Main and Service Pipe. J. H. Fitzgerald. Read at meeting of the Texas Gas and Electric Light Assn. at Laredo. An outline of what the writer believes necessary in laying and carrying out the actual work to be done. Discussion. 5800 w. Am Gas Lgt Jour—April 18, 1898. No. 19636.

Sulphur.

A New Method for the Determination of Sulphur in Gas. A brief description of the method and apparatus devised by Antonio Longi, of Rome, as published in the *Gazetta Chemica Italiana*, with editorial criticism. 2800 w. Jour of Gas Lgt—April 5, 1898. No. 19617 A.

Water Gas.

A New Method of Producing Water Gas. Carl Dellwik. From *Jernkontorets Annales*. Describes the process and makes comparisons between the theoretical value and possibilities of the three kinds of gases—producer gases, water gas by the old process, and by the new. Ill. 2800 w. Ir Age—April 28, 1898. No. 19900.

Welsbach.

Incandescence in Welsbach Mantles. H. Bunte. Abstract from the *Journal für Gasbleuchtung* and the *Journal de l'Eclairage au Gaz*. Investigations demonstrating that the highly luminous properties are due to the high temperatures which they are capable of attaining. 1500 w. Gas Engs' Mag—April 11, 1898. No. 19776 A.

The Welsbach Incandescent Electric Lamp. A. M. Gibson. Gives particulars taken from the complete specification. 1800 w. Elec Rev, Lond—April 15, 1898. No. 19770 A.

SEWERAGE.

Disposal.

Chemical Treatment of Sewage at New Rochelle, N. Y. Describes the operation of a small plant. 700 w. Eng Rec—April, 1898. No. 19726.

Sewage Disposal at Newport, Isle of Wight. Illustrates a chemical treatment plant and an inverted syphon. 700 w. Eng Rec—April 16, 1898. No. 19624.

Sewage Disposal Through the Action of Bacteria. W. M. Watson. Information gathered from leading bacteriologists, chemists and engineers, and from the writer's experience. 2300 w. Can Eng—April, 1898. No. 19568.

The Proper Disposal of Sewage. C. E. Grumsky. Read before the Convention of Health Officers in San Francisco. Discussing how sewage should be disposed of and collected. Filtration is considered the solution. 3700 w. San—April, 1898. No. 19403 D.

Purification.

The Oxygen System of Sewage Purification. W. M. Watson. Explains the System of the Sewage Purification Co., of Dublin, Ireland. 700 w. Can Eng—April, 1898. No. 19569.

The Proper Use of Land in Connection with Sewage Purification. W. J. Dibdin. Consideration of means of attaining the best results. 1400 w. San Rec—April 1, 1898. No. 19548 A.

Sewers.

A Composite Sewer. Illustrates sewers of concrete and expanded metal used in Boston. 300 w. Eng Rec—April 2, 1898. No. 19414.

A Steel Street Sewer. Illustrates a 48- and a 66-inch rivetted steel sewer in Jersey City. 500 w. Eng Rec—April 2, 1898. No. 19413.

Damages from Imperfect Surface Drainage. Review of decision of Michigan Supreme Court awarding damages against a city for negligent construction of surface drainage system. 800 w. Eng Rec—April 16, 1898. No. 19620.

The Acheres Aqueduct, Paris. Describes syphon and masonry conduit on the main outfall sewer of Paris. Ill. 1700 w. Eng Rec—April 9, 1898. Serial. 1st part. No. 19474.

The New Intercepting Sewerage System of Chicago. Illustrates details of this work, which is described in outline, for turning sewage from Lake Michigan toward the drainage canal. 1600 w. Eng Rec—April 9, 1898. No. 19472.

The New Intercepting Sewer for Chicago. Describes this important work and gives an abstract of the specifications for the main conduits on Lawrence ave., and 39th street. Ill. 6500 w. Eng News—April 21, 1898, No. 19700.

Ventilation.

Experiments on Secondary Ventilation Pipes for House Drainage Systems. (Versuche über die Notwendigkeit der Sekundären Entluftungsrohre bei Hausentwässerungsleitungen.) A. Unna. With full details of important experiments, using gages on the various siphon traps under different conditions, showing the effects of flushing with and without proper ventilation. Two articles. 7500 w. Gesundheits-Ingenieur—Feb. 28, March 15, 1898. No. 19861 each B.

WATER SUPPLY.

Brooklyn Water Works.

The New Pumping Engines and Boiler House at the Ridgewood Station of the Brooklyn Water Works. Illustrated description. 1700 w. Power—April, 1898. No. 19432.

Cement Pipe.

Test of Crushing Strength of Cement Pipe. Arthur S. Bent. Describes tests made to determine the amount of fill the pipes would stand when laid. 1200 w. Eng News—April 14, 1898. No. 19597.

Deep Well Pump.

The Iowa Agricultural College Deep Well and Pump, Ames, Ia. A. Marston. Gives results of test of well and pump under different

conditions. 1200 w. Eng Rec—April 2, 1898. No. 19412.

Detroit.

Water Supply of Detroit, Michigan. Report of the prosperous condition of the works, the reduction of rates, improvements made, &c. Ill. 1100 w. Fire & Water—April 23, 1898. No. 19738.

Fan Pump.

The Fan Pump. F. C. Hooper. Illustrates and describes a special instance of its use for mill water supply. 900 w. Sch of Mines Quar—Jan., 1898. No. 19918 D.

Filter Cribs.

Filter Cribs in the Allegheny River, near Pittsburg, Pa. Describes cribs built with the object of removing matter carried in suspension by the river. Ill. 1200 w. Eng News—April 28, 1898. No. 19793.

Germs.

The Vitality of Pathogenic Germs in Drinking Water. B. Meade Bolton. On the variability of the bacteria and experiments made to determine their vitality. 1300 w. San Rec—April 15, 1898. No. 19765 A.

Harrisburg, Pa.

Water Supply of Harrisburg. An account of the improvements made which have overcome the pollution of the water by culm, and by sewage, and increased the supply. 1200 w. Fire & Water—April 9, 1898. Serial. 1st part. No. 19520.

Meter Rates.

The Right to Sell Water by Meter Rates. Abstract of decision of the Superior Court of Pennsylvania establishing the legality of meter rates in case all supplies are not metered. 1000 w. Eng Rec—April 9, 1898. No. 19469.

Pumping Engine.

Test of a Triple Expansion Steam Pumping Engine at the St. Gall Waterworks. (Versuche an einer Dreistufigen Dampfpumpmaschine im Wasserwerk der Stadt St. Gallen.) A. Stodola. Full details of the test of this Sulzer engine are given, with a complete table of data and results. 3500 w. Schweizerische Bauzeitung—Feb. 19, 1898. No. 19832 B.

Purification.

The Purification of River Water Supplies. Allen Hazen. Especially devoted to a description and illustration of modern sand filters, showing details of construction, and demonstrating the success which has attended their use. 2500 w. Engineering Magazine—May, 1898. No. 19939 B.

Tank.

A Curious Historical Water Tank. Illustrated description of a cast-iron tank of 140,000 gallons capacity, built a century ago by the Manhattan Company of New York, to hold its banking franchise, which it obtained under the guise of a water company. 1000 w. Eng Rec—April, 1898. No. 19724.

Water Privileges.

The Privileges of a Water Company. Review of a decision of U. S. Circuit Court that a private company may be exempted from municipal taxation in return for free water for public purposes. 800 w. Eng Rec—April 23, 1898. No. 19719.

Watershed.

The Bronx Watershed. Describes this district which gives an additional supply to New York. 900 w. Fire & Water—April 16, 1898. No. 19634.

Water Supplies.

The Protection of Underground Water Supplies. John C. Thresh. Read before the Soc. of Engs, England. Considers briefly some sources of underground supply known to have caused epidemics, and the natural processes of purification. 3500 w. Brit Arch—April 8, 1898. Serial. 1st part. No. 19665 A.

Cheap Water for a Small Town. Illustrates a plant with gas engines and triplex pumps at Caledonia, N. Y., which furnishes water at a very low cost per capita. 1000 w. Eng Rec—April 23, 1898. No. 19725.

Water Works.

The Wachusett Reservoir and Aqueduct. Illustrates and describes temporary dam and important features of aqueduct of the metropolitan works for Boston and vicinity. 4000 w. Eng Rec—April 9, 1898. No. 19471.

MISCELLANY.

Baths.

See Architecture and Building, Construction.

Disinfection.

A New Apparatus for Continuous and Automatic Disinfection. (Ein neuer Apparat zur Kontinuirlichen und Automatischen Disinfektion.) Dr. H. Köhler. The disinfecting liquid is kept in circulation by capillary action, and evaporated from the surface of a porous plate. The liquid used is generally coal-tar containing a high percentage of carbolic acid. 2000 w. Gesundheits-Ingenieur—Feb. 28, 1898. No. 19860 B.

Plan.

The City's Plan. J. F. Harder. Discusses to some extent the plans of cities in general, but is chiefly devoted to New York and the improvements that should be made. Ill. 6700 w. Munic Af—March, 1898. No. 19555 C.

Public Franchises.

A Successful Substitute for Municipal Ownership. Alfred F. Potts. Indicates a solution of the question how the people may own and control street railways, water, telephone and light companies without resorting to municipal ownership. Outlines the plan of organization on which the Consumers' Gas Trust Co., of Indianapolis was formed. 2800 w. Munic Engng—April, 1898. No. 19396 C.

Sculpture.

Municipal Sculpture. Karl Bitter. Suggestions for the beautifying of New York by statues, fountains, fine buildings, and other decorative works of art, with reference to work in other cities. 10000 w. Munic Af—March, 1898. No. 19557 C.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

The Prussian Railroad Commission on the Epidemic of Accidents. Data from a memorial submitted by the Minister of Railroads to the Prussian Diet, on the provisions for safety and their effectiveness. 1400 w. R R Gaz—April 15, 1898. No. 19603.

Train Accidents in the United States in March. Detailed list and classified summary for the month named. 3500 w. R R Gaz—April 29, 1898. No. 19924.

Employes.

Railway Companies and Their Employés. H. P. Robinson. Extract from an article in *Locomotive Firemen's Journal.* The importance of co-operation, and an explanation of many matters not understood by employés. 2500 w. Ry Age—April 8, 1898. No. 19560.

German Railroads.

Notes on German Railroads. J. Pearson Pattinson. Some of the salient points of German railroad working, discussing passenger rolling stock, fares, stations and speed. 1800 w. R R Gaz—April 15, 1898. No. 19601.

Loading Lumber.

Loading Lumber as Lumbermen See It. Editorial published in *The Timberman* from the view of the shipper, in regard to the furnishing of box cars when required for valuable lumber, and the unjust charges when such cars are not furnished. 1300 w. Ry & Engng Rev—April 23, 1898. No. 19763.

Management.

Ethics of Railroad Management. William Taussig. An address before the Commercial Club of St. Louis, with editorial comment. Considers some of the points that might become subjects of railroad ethics. 5800 w. R R Gaz—April 15, 1898. No. 19599.

FINANCIAL.

American Railroads.

Mr. Acworth on American Railroads. Extracts from the fourth of a series of articles in the London *Times*. Considers the financial position of American railways and concludes that at least in the northeastern section they have reached a comparatively stable and prosperous position. 2000 w. R R Gaz—April 29, 1898. No. 19920.

Deserted Railway.

A Deserted Railway in New York. Concerning the Lebanon Springs railroad, extending from Chatham, N. Y., to Bennington, Vt., which has not been operated since Aug. 7, 1897. 1100 w. Ry Age—April 22, 1898. No. 19734.

Earnings.

Large Railroad Earnings. Reports the earnings of 120 railroads of the United States, for the month of March, which shows a gain of 15.3% over March, 1897. 1500 w. Bradstreet's—April 16, 1898. No. 19615.

Railroads.

The Nation's Railroads. George B. Waldron. On the development of the railroads of the United States, giving information also of the financial side. Ill. 1700 w. McClure's Mag—April, 1898. No. 19337.

Railway Finance.

Electric Railway Finance. W. R. Lawson. Part first is a historical review of the progress of electric railways, principally confined to Great Britain. 5200 w. Bankers' Mag, Lond—April, 1898. Serial. 1st part. No. 19498 B.

LEGAL MATTERS.

Claim Agents.

The Claim Agent. S. D. Webster. From a paper read before the St. Louis Ry. Club. Considers the information needed by a good claim agent and the personal qualities desirable. 2000 w. R R Gaz—April 15, 1898. No. 19605.

Employers' Liability Act.

Railway Companies and the Employers' Liability Act. Part first explains the arrangements made by the London and Northwestern railway company to meet the new conditions. 1000 w. Transport—April 1, 1898. Serial. 1st part. No. 19546 A.

Freight Rate Law.

The Supreme Court on the Nebraska Freight Rate Law. Editorial on the decision which nullified the Newberry freight-rate law, and the efforts being made to have it modified. 1600 w. R R Gaz—April 15, 1898. No. 19604.

Interstate Commerce.

The Dangerous Demands of the Interstate Commerce Commission. Milton H. Smith. Considers that the Commission's radical demands will not correct the evil which requires correction, and that all other evils are sufficiently guarded against by the Act as it stands. 6300 w. Forum—April, 1898. No. 19493 D.

Legislation.

Railroad Legislation in Massachusetts. Editorial on the railroad policy of this state, as shown in the recently passed law to help the Boston & Maine road to retain control of its leased lines, and the discussion during its passage. 1400 w. R R Gaz—April 8, 1898. No. 19468.

State Regulation.

State Regulation of Railways. Harry Perry Robinson. Discusses the effect of the decision of the United States Supreme Court in what is known as the Nebraska Maximum Rate case. 3300 w. N Am Rev—April, 1898. No. 19357 D.

MOTIVE POWER AND EQUIPMENT.

Air-Brake Hose.

Specifications for Air Brake Hose. Report of the Committee of the Central Ry. Club, with tests and standard specifications of the L. S. & M. S. Ry., the Erie Ry. and the C. B. & Q. Ry.

4200 w. Central Ry Club—March, 1898. No. 19591 D.

Balanced Valves.

The Application of Balanced Valves to Locomotives. (Die Anwendung der Entlasteten Schieber bei Locomotiven.) August Birk. Describing the various methods of relieving the pressure from locomotive slide valves, in British, French and American practice. 2000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst —April, 1898. No. 19849 D.

Car Lighting.

Experience with Acetylene Gas for Car Lighting. Letter from P. W. Resseman, giving information of the economy and convenience resulting from the adoption of this system of lighting on the Pontiac Pacific Junction Ry. of Canada. 600 w. Eng News—March 31, 1898. No. 19317.

Chilled Wheels.

The Chilled Cast-Iron Wheel. R. P. C. Sanderson. Considers the relative merits of cast-iron and steel tired wheels, favoring the former. 3300 w. R R Gaz—April 29, 1898. No. 19921.

Couplers.

The M. C. B. Coupler. Gustav Giroux. From a paper presented at meeting of the Western Railway Club. On the advantage accruing from the use of drop tests of couplers, with data derived from tests. 3000 w. R R Gaz—April 8, 1898. No. 19466.

Drawbar.

Improvement in Railway Drawbars. (Verbesserung der Zugvorrichtung für Eisenbahnwagen.) H. Wick. An improved spring drawbar, suggested as the standard for the German railways. 1200 w. Glaser's Annalen—March 15, 1898. No. 19838 D.

Locomotive Boiler.

Fitting Pedestal Binders and Setting Frames. Ira A. Moore. Showing how back frames may be properly lined and squared up when they have been taken down to allow boiler repairs. 2000 w. Loc Engng—April, 1898. No. 19367 C.

Locomotive Details.

Unnecessary Labor in Locomotive Details. P. M. Hammett. Extracts from paper read at meeting of the New England R R Club. Examines the principles of design with a view to securing economical results, and the conditions of shop practice. 1400 w. R R Gaz—April 8, 1898. No. 19464.

Locomotives.

Compound Consolidation Locomotives for the South Carolina & Georgia Railroad. Illustrated description of heavy two-cylinder compounds built by the Richmond Locomotive Works. 500 w. R R Gaz—April 22, 1898. No. 19703.

Consolidation Locomotive—Cleveland, Cincinnati, Chicago & St. Louis. Illustrated detailed description giving dimensions. 700 w. R R Gaz—April 15, 1898. No. 19602.

Locomotive Design. Francis J. Cole. On the determination of the proper working stress of materials. 2000 w. Am Eng & R R Jour—April, 1898. Serial. 1st part. No. 19340 C.

Modern British Express Engines—Their Construction and Work. Charles Rous Martin. Illustrates and describes various types, giving historical information. 5500 w. R R Gaz—April 8, 1898. No. 19465.

New Class "G." Locomotives for the Wabash. Description with dimensions and illustrations of locomotives all of whose important parts are interchangeable. 1000 w. R R Gaz—April 1, 1898. No. 19346.

New High-Speed Locomotives for the Northern Railway of France. (Nouvelles Machines à Grande Vitesse de la Compagnie du Nord.) The specifications of the new four-cylinder compound express locomotives designed by M. du Bousquet for the Northern Railway of France, with plate of details and photographic elevation. 2000 w. 1 plate. La Revue Technique—March 25, 1898. No. 19813 D.

New Standard Locomotives—Grand Trunk Railway. Illustration and principal dimensions with brief description. 800 w. Am Eng & R R Jour—April, 1898. No. 19342 C.

106-Ton Twelve-Wheel Locomotive; Great Northern Railway. Illustrates and describes an enormous locomotive and its interesting features. 1200 w. Eng News—April 14, 1898. No. 19596.

Six Coupled Tank Engine for the Trans-Manchurian Railroad. Illustrated description with dimensions. 700 w. R R Gaz—April 29, 1898. No. 19922.

Southern Railway Ten-Wheelers. Illustration and general description. 800 w. Loc Engng—April, 1898. No. 19366 C.

The Performance of a Four-Cylinder Compound Locomotive. Richard A. Smart. A paper presented before the St. Louis Railway Club. A record of tests for the purpose of investigating the cylinder performance of the compound locomotive at high speeds. Ill. 1600 w. Pamphlet. St. Louis Ry Club. No. 19496 D.

The Locomotives of the Paris, Lyons and Mediterranean Railway. Information concerning types of engines constructed by this company, with leading particulars of two new locomotives and illustrations showing their details. 1700 w. Engng—April 15, 1898. No. 19746 A.

Mail Car.

Mail Car—L. S. & M. S. Railway. Illustrated description of a carefully planned mail car for the Lake Shore & Michigan Southern Railway. 500 w. Ry Mas Mech—April, 1898. No. 19561.

Motor Car.

A Composite Steam Motor Car for the Erie Railroad. Illustration, general dimensions and equipment. 400 w. Ry & Engng Rev—April 2, 1898. No. 19422.

Steam Motor Cars by the Baldwin Locomotive Works. Illustrated description of two recently completed cars, one to be used on the C. H. & D. R. R. and the other on the D. & L. N. R. R. 900 w. Am Eng & R R Jour—April, 1898. No. 19341 C.

Oil-Sprinkling Car.

Oil-Sprinkling Car—Long Island Railroad.

Engravings showing the details, with description, and a letter from C. S. Addison, General Road Master, stating the advantages. 800 w. R R Gaz—April 29, 1898. No. 19925.

Paint Oil.

Note on a Test of a New Paint Oil. William G. Raymond. Illustrates and describes the test made, giving results which were very favorable. Recommends it for car and depot painting. 1700 w. R R Gaz—April 29, 1898. No. 19923.

Roofing.

Car Roofing. Taken from discussion on this subject at a meeting of the North-West Ry. Club. The opinions of Alfred Child of the Northern Pacific, and C. D. Brooke, of the St. Paul & Duluth Ry. 900 w. R R Gaz—April 8, 1898. No. 19467.

Sleeping Car.

New Sleeping Cars for the Prussian State Railways. (Neue Schlafwagen der Preussichen Staatseisenbahn-Verwaltung.) An improved stateroom car with corridor on one side, excellent toilet, and vestibuled platforms. 1200 w. 1 plate. Glaser's Annalen—April 1, 1898. No. 19839 D.

Tank Feeder.

Pumping Water with Locomotives. Illustrated description showing the features and operation of a railway water-tank feeder; patented by John W. Skilton of Chicago. 900 w. Ry & Engng Rev—April 23, 1898. No. 19761.

Train Resistance.

The Resistance of Rolling Stock to Traction at High Speeds. (Résistance à la Traction du Material Roulant à Grand Vitesse.) F. Barbier. A discussion of the recent experiments made on the Northern Railway of France, with diagrams and curves, showing the relation between speed and resistance. 2000 w. Le Génie Civil—April 9, 1898. No. 19812 D.

Train Stopping.

The Engine Truck Brake as an Aid in Train Stopping. Report of committee presented at meeting Air Brake Men's Assn., at Baltimore. 1800 w. Ry Age—April 15, 1898. No. 19633.

Tubular Car.

The Church and Ettenger Tubular Car. Illustrates and describes this construction and discusses why it is not a success in the United States, while it seems in favor in Tasmania. 3000 w. R R Car Jour—April, 1898. No. 19513.

Wrecking Crane.

Steam Wrecking Crane for the Atchison, Topeka & Santa Fé. Illustrates and describes a heavy crane of 35 tons capacity designed for emergency service. 1100 w. R R Gaz—April 1, 1898. No. 19347.

NEW PROJECTS.

China.

China, and Chinese Railway Concessions. Clarence Cary. Discussing the railway possibilities in China, and the general subject of railway-extension; also other business enterprises. 6000 w. Forum—Jan., 1898. No. 19486 D.

The Proposed Railways of Shansi, China. These railways will connect Pekin and the coast line with extensive deposits of coal and iron. The contour of the country and the difficulties to be met in the construction are discussed. 1200 w. Eng News—March 31, 1898. No. 19320.

Colombia.

Railway Contract in Colombia. Copy of a contract for the construction of a railroad from the port of Girardot to the Savannah of Bogotá. 800 w. Cons Repts—April 19, 1898. No. 19660 D.

Greece.

Piraeus-Larissa Railway. Gives an account of the work already done, and that remaining. 800 w. Cons Repts—April 28, 1898. No. 19903 D.

New Lines.

Opening of New Lines. An account of the opening of the Great Northern's Leen Valley extension, and the Lambourn Valley railway. 2200 w. Transport—April 8, 1898. No. 19670 A.

Railway Contract.

Newfoundland Railway Contract. Synopsis of a contract between the government of Newfoundland and Robert G. Reid, of Montreal. 3000 w. Cons Repts—April 27, 1898. No. 19778 D.

Venezuela.

Railway Contracts in Venezuela. Translations of contracts made with the Government for the construction of the Perico-Crucero and the Los Teques-Cua railroads. 1800 w. Cons Repts—March 30, 1898. No. 19327 D.

PERMANENT WAY, BUILDING AND FIXTURES.

Ballast.

Tests of Gravel and Broken Stone for Use as Railway Ballast. (Untersuchungen von Kies und Steinschlag zur Beurtheilung ihres Werthes als Stopfmaterial für den Eisenbahnoberbau.) M. Rudeloff. Important researches made at the government testing bureau, with especial reference to various German gravels, but also of value for other localities. Many tables and diagrams. 18000 w. Mitt aus d Kgl Tech Versuchsanstalt—Part 6, 1897. No. 19865 G.

Boston Union Station.

New Southern Union Station at Boston. Illustrated description of a new station, the largest ever constructed, to be used by the Boston & Albany, the New England, and the New York, New Haven & Hartford systems. 1500 w. Ry & Engng Rev—April 2, 1898. No. 19423.

Frog Formulas.

A Method of Determining Railway Crossing Frog Formulas. G. B. Zahniser. Mathematical. 500 w. Eng News—April 21, 1898. No. 19696.

Interlocking.

Small Interlocking Plant at East Clinton, Ill. Illustrated detailed description. Ry & Engng Rev—April 16, 1898. No. 19678.

Paris Station.

The Orleans Station in Paris. An account of the location and plans for two new stations in

Paris, for the Orleans Railroad of France. Ill. 1300 w. RR Gaz—April 1, 1898. No. 19349.

Rails.

Converting Worn Out Rails into Posts. F. G. Lynde. Describes a process by means of which rails were split and made into fence posts, at a cost of two and a quarter annas per post. Ill. 2000 w. Ind Engng—March 5, 1898. No. 19554 D.

Railway Shops.

Concord Shops—Boston & Maine Railroad. Illustrated descriptions of the boiler plant, power house, generators, motors, and steam heating system. 4500 w. Am Eng & RR Jour—April, 1898. No. 19338 C.

Steel Ties.

Experience with Steel Ties on the Gothard Railway, Switzerland. Particulars as to the experience of this road, taken from a report showing the results obtained up to Jan., 1898, and giving the present opinions of the officers of the railway. 1000 w. Eng News—April 7, 1898. No. 19460.

Steel Cross Ties on the St. Gothard Railway. (Les Traverses d'Acier au Chemin de Fer du Saint Gothard.) A review of the experiences with steel ties from 1882 to 1898. In addition to the constructive advantages, a marked economy over wooden ties appeared. 1000 w. La Revue Technique—April 10, 1898. No. 19819 D.

The Use of Metal Ties on the Turkish Railways. (Emploi des Traverses Métalliques sur les Chemins de Fer Turcs.) A. Magnier. With illustrations showing the machines for transporting and placing sections of track, with steel sleepers. 2000 w. 1 plate. Le Génie Civil—March 19, 1898. No. 19800 D.

Switch Leads.

Simple and Accurate Rules for the Computation of Shortened Switch Leads. Wellington B. Lee. Gives a set of arithmetical formulas which give surprisingly accurate results. 800 w. Eng News—April 21, 1898. No. 19697.

Turntable.

Designs for Standard 60-ft. Center-Bearing Locomotive Turntable. C. L. Strobel. Illustrated description of recent designs of the writer differing from the usual type in that no trailing wheels are used, and also in the manner in which the load is supported at the center. 1200 w. Eng News—March 31, 1898. No. 19319.

The Use of Electricity for Turning Locomotives and Cars. J. G. Rawn. Describes a plan devised for turning the 60-ft. turntable at Chillicothe, O., by means of an electric motor. Ill. 600 w. Am Elect'n—April, 1898. No. 19449.

Water Station.

Water Station Improvements on the Wheeling & Lake Erie Railway. Illustrated description of tanks supported on cast-iron columns, and with other improvements in details. 800 w. Ry & Engng Rev—April 9, 1898. No. 19592.

TRAFFIC.

Fares.

Railroad Fares and Passenger Travel. H. G. Prout. A discussion of this important problem by an expert, showing the intricacy of the subject and the many interdependent factors of which it is composed. 3000 w. Engineering Magazine—May, 1898. No. 19934 B.

Pooling.

Railroad Pooling and Sound Public Policy. Frank J. Firth. Extracts from a paper read before the Merchants' Assn. of New York. Calls attention to the large number directly or indirectly dependent upon the successful operation of the railroads, explains pooling and the advantages made possible by its agreements. 1700 w. R R Gaz—April 22, 1898. No. 19702.

STREET AND ELECTRIC TRAMWAYS.

Accumulators.

Experiments with an Accumulator Test Car, with Shunt Motors and Improved Regulator. (Versuchsfahrten mit einem Akkumulatorenwagen mit Nebenschlussmotoren und einem Neuen Steuerapparat.) E. G. Fischinger. With elaborate power diagrams and detailed drawings of the controller system. 2500 w. Elektrotechnische Zeitschr—March 24, 1898. No. 19889 B.

Baltimore.

The System of the Baltimore and Northern Electric Railway Company. Illustrated detailed description. 2500 w. St Ry Jour—April, 1898. No. 19417 D.

Belgium.

Belgian Tramways and Light Railways. Illustrated description of the system of communication. There are twenty-nine lines belonging to seven companies. Ill. 2000 w. Ry Wld—April 7, 1898. No. 19638 A.

Boston Elevated.

The Boston Elevated Railroad. Information concerning the construction, equipment and operation of this proposed road. Ill. 1800 w. R R Gaz—April 22, 1898. No. 19704.

Boston Ry. Stations.

Competitive Designs for Stations on the Boston Elevated Railway. Reproductions of nine of the eleven designs recently submitted, giving the conditions of the competition. 400 w. Eng News—March 31, 1898. No. 19316.

Brake.

The Electromagnetic Brake of the Union Electric Company. (Die Elektromagnetische Bremse der Union Elektricitäts-Gesellschaft.)

M. F. A. Kubierschky. Illustrated description of a brake used on the Dresden tramways. A disc on the axle is acted upon by stationary magnets. The current is taken from the motors. 2000 w. Elektrotechnische Zeitschr—April 7, 1898. No. 19891 B.

Car Building.

Building Cars for Export. Describes an improved system for the construction of "knock down" cars, or of cars that can be taken apart and snugly packed for shipment. Ill. 1000 w. St Ry Rev—April 15, 1898. No. 19674 C.

Combined Plant.

A Combined Street Railway and Electric Lighting Plant at Toledo, Ohio. W. S. Smith. An account of the company's experiments with different systems of motive power, and an illustrated description of its present fine station. 1800 w. Elec Wld—April 23, 1898. No. 19691.

Conduits.

Power Consumption on the Lenox Avenue Conduit Electric Road, New York City. G. F. Sever. Brief description of the construction and method of operation, with results of two series of tests when operated at 300- and 500-volts respectively. Ill. 1100 w. Sch of Mines Quar—Jan., 1898. No. 19919 D.

The Sewall Conduit on the Chicago City Railway. Describes the construction and discusses the commercial advantages. Ill. 1200 w. Elec Eng, N Y—April 7, 1898. No. 19430.

Dublin, Ireland.

New Construction in Dublin, Ireland. Illustrated detailed description of the Electric system of the Dublin United Tramways Co. 2700 w. St Ry Jour—April, 1898. No. 16421 D.

Electric Railway.

The Electric Railway. W. R. Garton. Abstract of a paper read before the Chicago Elec. Assn. Reviews the electric railway field from the earliest use to the present, touching on construction, methods, equipments, etc. 3400 w. St Ry Rev—April 15, 1898. No. 19672 C.

Grade Grossings.

The Protection of Grade Crossings. Concerning laws of various states, and the interlocking plants of numerous electric roads and their operation. Ill. 2400 w. St Ry Rev—April 15, 1898. No. 19676 C.

London Railways.

London's Internal Railways. An editorial review of London's position in regard to internal traveling facilities. 1600 w. Engr, Lond—April 8, 1898. No. 19649 A.

Massachusetts.

The Report of the Massachusetts Special Commission on Street Railways. Editorial discussion of this report and points suggested by it. 2500 w. Eng News—April 7, 1898. No. 19459.

Montreal.

Montreal Island Belt Line Railway. Illustrated description of the line with the equipment and history of the undertaking. 3500 w. Can Eng—April, 1898. No. 19571.

Motors.

Motor Axes and Motor Sizes. (Ueber Motoraxen und Motor Grössen.) Max Schiemann. A discussion of the relative advantages of driving one or more axles, together with the commercial advantages of various sizes of motors. 1200 w. Deutsche Zeitschr f Elektrotechnik—April 1, 1898. No. 19881 E.

Narrow Gauge.

The Narrow Gauge Electric Road of the Groenendijk Sugar Works, Holland. (Die Elektrische Schmalspurbahn der Zuckerfabrik Groenendijk, in Holland.) J. Werther. Illustrated description of an electric road used for conveying the sugar beets from the fields to the works. One motor car draws a train of special tipping cars. 2500 w. Electrotechnische Zeitschr—April 14, 1898. No. 19892 B.

Poles.

Poles. Considers the selection, setting, painting, and practice of different roads. Ill. 3200 w. St Ry Rev—April 15, 1898. No. 19675 C.

Power Stations.

Some Expedients in Power Station Practice. J. H. de Gruchy. Discusses the causes of short circuits, and other matters, with devices for rapid work and for convenience. Ill. 1800 w. St Ry Rev—April 15, 1898. No. 19673 C.

Resistance.

Methods of Determining the Resistance of the Railway Feeder Circuits and the Ground Return Losses. Albert B. Herrick. Describes methods of making these determinations without a pressure wire. 1600 w. St Ry Jour—April, 1898. No. 19419 D.

Return Conductors.

The Best Arrangement of Return Conductors for Electric Railways. (Ueber die Günstigste Anordnung der Rückleitungen Elektrischer Bahnen.) Fr. Natalis. A highly mathematical discussion of the arrangement of return feeders with formulas for practical application. 6000 w. Electrotechnische Zeitschr—March 17, 1898. No. 19888 B.

Sectional Conductor Systems.

Sectional Conductor Electric Railways. George T. Hanchett. Illustrated description of systems aiming at moderate cost, and a permanent way free from unsightly and dangerous devices. 3200 w. Elec Wld—April 23, 1898. Serial. 1st part. No. 19692.

Third-Rail System.

The Murphy Third-Rail Street Railway System. Describes the most recent attempt of avoiding overhead construction without excessive cost. Ill. 2000 w. Elec Eng, N. Y.—April 7, 1898. No. 19431.

Trolley Construction.

Overhead Trolley Construction on New Drawbridge in New York. Designed to give complete metallic contact for the trolley connection the entire length of the bridge when the draw is closed. Ill. 600 w. St Ry Jour—April, 1898. No. 19420 D.

BOOKS OF THE MONTH

DE PONTIBUS. A Pocket-Book for Bridge Engineers by J. A. L. Waddell, C. E., B.A. Sc., Ma. E. New York: John Wiley and Sons. London: Chapman and Hall, Limited. Morocco, 416 pages.

Mr. Waddell's long study of the Latin tongue is amply justified by this short study "concerning bridges." His prefatory apology is entirely unnecessary. The curiosity excited by the delightful title is more than warranted by the contents of the volume. "Easy reading means hard writing," said Thackeray, and if it is true, there can be no doubt that "De Pontibus" is the result of hard work and harder thought, for here is found the gist of matter which might easily have occupied double the space. There is so much to commend about Mr. Waddell's work that one is troubled to select the most important parts. One feature, however, stands out prominently. The use of language and the methods of demonstration are such that they may be understood, we were almost going to say, by the multitude; certainly few, even of the least technical engineers, will fail to appreciate the meaning of the author's words, and more than this, will not only understand but will enjoy.

The introductory chapter contains valuable suggestions regarding the inappropriateness of competitive designs in bridge work, and the remarks may well be applied to some other branches of engineering.

The series of propositions, printed in large type followed by comments in smaller type, which compose the second chapter, are among the clearest presentation of principles which we remember to have seen in print.

Aesthetics in Design, Movable Bridges in General, Designing of Piers, Office Practice, Triangulation, are suggestive chapter headings, taken at random from the Table of Contents, which covers the whole subject of bridge design.

There is an excellent alphabetical index and what strikes us as a novelty, a list of the tables, which gives also the formula from which each table is calculated.

So much for the matter; as for the manner, the book is well printed on excellent paper and is a convenient size for the pocket, but why the superfluous flap? Why not print the title on the back. round the corners, and so make a book which is more suited both to the library and the pocket than this form is to either?

THE MARINE STEAM ENGINE. A treatise for Engineering Students, Young Engineers, and Officers of the Royal Navy and Mercantile Marine. By the late Richard Sennett and Henry J. Oram. London, New York and Bombay: Longmans, Green & Co., 1898.

Sennett's treatise on the marine engine has long been known as a standard authority and the eminent position occupied by the author as well as the thorough and reliable character of the work have made it for many years one of the indispensable books of reference in the branch of engineering of which it treats.

Since the appearance of the last edition which had the revision of Mr. Sennett himself, in 1885, many changes have taken place in the practice of marine engineering, and while the older editions of the work will always have a historical interest, they are now altogether too far behind present practice to be of immediate service. It is, however, a most graceful tribute to the memory of the deceased author to place his name upon the title page of this book in connection with that of Mr. Oram, as the work has been so thoroughly rearranged and rewritten that the latter gentleman might well have claimed the authorship alone.

In this connection it is interesting to quote the introductory note of Sir John Durston, the present engineer-in-chief of H. M. Navy, in which he says: "To the many who knew the late Richard Sennett, my old friend and predecessor in office, and appreciated his work and worth, and

regretted the all too early closing of his brilliant career, it will be a source of gratification that the revision of this book has been undertaken by so capable a marine engineer as Inspector of Machinery H. J. Oram, R. N.

"Mr. Oram has acquired a vast amount of special knowledge and experience of marine machinery of the latest types, and it is believed this has been incorporated in the present edition in a manner that will make it of great value to students, young engineers and officers of the Royal and mercantile navies in carrying on their studies and duties."

An examination of the book proves that Sir John Durston's commendation has been fully warranted; the work being fully up to date in many points upon which until now no collected information has been available. The brief historical introduction is followed by a classified and systematic treatment under the main divisions, The Boiler; The Steam; The Mechanism; The Propeller; and General; each of these being again divided into chapters giving a sub-classification.

It is impossible here to give a detailed review of the very full treatment of the subject which Mr. Oram has given, but some points are especially worthy of mention. The marine boiler is treated according to the efficiency obtained, computed from the total calorific power of the fuel used, this method being now in general use in land tests, and such recent data as the tests of the Powerful are included in the discussion. Liquid fuel is given place, and water-tube boilers have an entire chapter, with many illustrations and descriptive details. Radial valve gears are shown, and many arrangements of cylinders for various designs of multiple expansion engines. The very full treatment of the construction and arrangement of engine details forms a characteristic feature of the work, and it is in just such a point that a more general treatise is apt to be deficient. The vital point of auxiliary machinery is not neglected, and altogether it is not too much to say that the work is the latest exposition of the modern science and practice of marine engineering.

THE CALORIFIC POWER OF FUELS. By Herman Poole, F. C. S. New York: John Wiley & Sons; London: Chapman & Hall, Limited. 1898.

Mr. Poole has set out to give us an English version of Scheurer-Kestner's treatise on the *Pouvoir Calorifique des Combustibles*, but the work has grown on his hands and the result is almost a new book, based indeed on the work of the French author, but containing much that adds to its value.

There has been need for some time of a good treatise on the practical applications of calorimetry, especially since the general disposition of mechanical engineers to rate steam generators by their efficiency of performance has continued to call for some adequate method of determining the correct calorific power of any given fuel. Papers have been presented before engineering societies, and discussions have been most animated, but any one who really wanted to know something about the subject from a practical standpoint was obliged either to have recourse to foreign authors or else dig out from the scattered transactions of technical associations the information required.

Mr. Poole has now collected the matter into a convenient and satisfactory shape, and beginning with the various forms of fuel calorimeters for solid and gaseous fuels he passes on to the practical use of both calometric and chemical tests, concluding with the allied subject of gas analysis. A valuable set of tables follow, and the book is well indexed.

LA PHOTOGRAPHIE ET L'ETUDE DES NUAGES. Par Jacques Boyer. Paris: Charles Mendel. 1898.

The application of photography for recording fleeting scientific phenomena is becoming more and more general, and its use in connection with the difficult branch of meteorology which deals with the study of the clouds has enabled a much more rapid advance to be made than has hitherto been possible.

The international meteorological congress placed this subject in the hands of the directors of a number of the best known observatories for the purpose of collecting and classifying the negatives obtained from many sources, and this work having terminated at the close of the year 1897

makes Professor Boyer's little work timely and appropriate.

Apart from the interest which these studies have for physicists and meteorologists there is much of engineering value in the arrangement of the photographic theodolites and the methods of determining the altitude of cloud strata at the time of photographing. In this respect the subject bears a close relation to the modern art of photographic surveying, and the two allied applications of photography to the science of exact measurement will undoubtedly be of mutual assistance and value.

Professor Boyer's discussion of the subject is therefore well worthy of perusal by engineers as well as physicists, and the clear and scientific manner in which he has treated it will add to his already high reputation.

BOOKS RECEIVED.

Alternate Currents in Practice. Translated from the French of Loppé and Bouquet by Francis J. Moffet, B. A. (Lond.) London and New York: Whittaker & Co. 1898.

The Journal of the Iron and Steel Institute. Vol. LII. Edited by Bennett H. Brough, Secretary. London: E. & F. N. Spon. New York: Spon & Chamberlain. 1898.

House-Drainage and Sanitary Plumbing. By Wm. Paul Gerhard, C. E. Seventh Edition. Van Nostrand's Science Series. New York: D. Van Nostrand Company. 1898.

Interstate Commerce Commission. Ninth Annual Report on the Statistics of Railways in the United States, for the year ending June 30, 1896. Prepared by the Statistician to the Commission. Washington: Government Printing Office. 1897.

Annual Report of the Minister of Mines for the year ending 31st December, 1897, being an account of mining operations for gold, coal, etc., in the province of British Columbia. Victoria, B. C.: Printed by Richard Wolfenden, Printer to the Queen's Most Excellent Majesty. 1898.

Proposed Sea Water Fire Pipe Line for the City of New York. Reports of Chief of Department Hugh Bonner and Consulting Engineer Foster Crowell. New York: 1897.

The Georgian Period, being Measured Drawings of Colonial Work. By Frank E. Wallis, David A. Gregg, and others. Part I. Portfolio of 33 plates. Boston: American Architect and Building News. 1898.

Proceedings of the Annual Meetings of the Pacific Coast Gas Association, 1893-1897. Oakland, California: Oakland Enquirer Publishing Co. 1897.

American Gazetteer of Power Plants in the Principal Cities and Towns of Pennsylvania for the year 1897. Cleveland, Ohio: American Gazetteer Co. 1897.

Coal Catechism. By William Jasper Nicolls, M. Am. Soc. C. E. Philadelphia and London: J. B. Lippincott Co. 1898.

The Designing of Cone Pulleys. A Non-approximate, Graphical Solution for the Problem of Proportioning Cone Pulleys. By Walter K. Palmer, M. E. Lawrence, Kansas. 1898.

Notes on Heat and Steam. By Charles H. Benjamin, M. E. Cleveland, Ohio: Charles H. Holmes. 1898.

The Traction Engine, its Use and Abuse. By James H. Maggard. Philadelphia: David McKay. 1898.

A Treatise on Magnetism and Electricity. By Andrew Gray, LL.D., F.R.S., Vol. I. London: Macmillan & Co., Limited. New York: The Macmillan Company. 1898.

Workingmen's Insurance. By William Franklin Willoughby, United States Department of Labor. New York and Boston: Thomas Y. Crowell & Co. 1898.

Hydraulic and Placer Mining. By Eugene B. Wilson. New York: John Wiley & Sons. London: Chapman & Hall, Limited, 1898.

Gas, Gasoline and Oil Vapor Engines, For Stationary, Marine and Vehicle Motive Power. By Gardner D. Hiscox, M. E. New York: Norman W. Henley & Co. 1898.

The Storage Battery, A Practical Treatise on the Construction, Theory and Use of Secondary Batteries. By Augustus Treadwell, Jr., E. E. New York: The Macmillan Company. London: Macmillan & Co., Limited, 1898.

The Calorific Power of Fuels, Founded on Scheurer Kestner's Pouvoir Calorifique des Combustibles. By Herman Poole, F. C. S. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

The Resistance and Propulsion of Ships. By William F. Durand. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

The Purification of Public Water Supplies. By John W. Hill. New York: D. Van Nostrand Company. 1898.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

United Ordnance and Engineering Co., Ltd., with which is incorporated Messrs. Easton, Anderson, and Goolden, Ltd., Erith, England.=Handsome catalogue of multipolar continuous current dynamos and motors; with description of mode of manufacture, with full dimensions, prices, illustrations, and description.

Adolphe Crosbie, Ltd., Wolverhampton, England. = Catalogue of paints, oxide pigments, varnishes, etc., with samples of work, and prices.

Lucas & Davies, 67 Farringdon Road, London. =Illustrated price list of working models of stationary, locomotive and marine engines and boilers.

J. & F. Havard, Britannia Iron Works, Bedford, England.=Catalogue of agricultural implements, oil engines and light railway rolling stock, fully illustrated with prices and all usual particulars.

Humpidge, Holborrow & Co., Ltd., Stroud, Glos., England.=Price list of the Dudbridge gas engines up to 25 h. p., with prices and half tone illustrations.

Beaumont's Pump Works, Stockport, England. =8 page illustrated price list of the "Rapid" centrifugal pumps and the Beaumont water lifter, with directions for fixing.

Jas. B. Petter & Sons, Nautilus works, Yeovil, England.=(*a*) Illustrated price list of the "Destructor" kitchen ranges; (*b*) specimen order form.

Hartley & Sugden, Ltd., Halifax, England.= Handsomely illustrated catalogue and price list of welded boilers with automatic regulators for the steam heating of buildings; also French edition with dimensions in metrical system. Fully coded.

W. J. Wells Smallfield, Horley, Surrey.= Sheet price lists (*a*) of gas and oil engines; (*b*) of calcium carbid bicycle lamps.

Julius Harvey & Co., 11 Queen Victoria St., London, E. C.=Illustrated price list of mining machinery, including gold crushing plant, light locomotives and pumps.

Lee Howl & Co., Ltd., Tipton, Staffs., England.=Export catalogue of steam, rotary and force pumps; fully coded and priced for each machine, with abbreviated specifications.

Woods & Co., Suffolk Iron Works, Stowmarket, England.=Catalogue of agricultural machinery; also of wagons and carts. Fully illustrated, with usual data as to sizes, prices, etc.

Smith and Grace, Thrapston, England.=Catalogue with illustrations, particulars and prices of Smith's patent screw boss pulleys; also of couplings, pedestals, hangers and shafting accessories.

Smedley Bros., Ltd., Eagle Iron Works, Belper, England.=Illustrated catalogue of edge runner grinding mills. 8½×11". Paper cover 24 pp.

Thos. H. Dallett & Co., Philadelphia, U. S. A. =Handy catalogue of portable power and electric drills, boiler shell drills, hand drills, electric portable planers, flexible couplings, and special machinery. Many illustrations of these convenient tools, with descriptive data and extensive list of users.

Foster Engineering Co., Newark, N. J., U. S. A.=Catalogue of steam specialties, including the Foster pressure regulator, pump governors, safety stop valves, check valves and other high-grade specialties for steam, water, air, or gas.

The Diamond Rubber Co., Akron, Ohio, U. S. A.=Pamphlet catalogue of mechanical rubber goods, belting, hose, sheet packing, piston packing, diaphragms, &c.

Sullivan Machinery Co., Chicago, Ill., U. S. A.=Handsome catalogue of the various forms of the Sullivan Diamond Prospecting Core Drill, showing examples of its successful use in coal and metal mining in all parts of the world.

Also catalogue of the Sullivan rock drills and channelling machines, as used in mining and quarrying.

Stanley G. Flagg & Co., Philadelphia, Pa., U. S. A.=Descriptive catalogue of steel, malleable iron, and gray iron castings, with directions as to the various uses to which they may be put, instructions with regard to patterns, and description of the qualities possessed. A priced and illustrated list of special steel bicycle parts is also given.

New Haven Mfg. Co., New Haven, Conn., U. S. A.=A handsomely illustrated catalogue of machine tools, including lathes, planers, drills, slotters, and smaller tools; with a special telegraphic code.

Queen & Co., Incorporated, Philadelphia, Pa., U. S. A.=Illustrated catalogue of engineering instruments and materials. The list covers transits, theodolites, levels, compasses, sextants, and many forms of minor instruments used by the engineer and surveyor.

Sprague Electric Company, New York.=Electric Motors in the Art of Printing. A most beautiful specimen of the printer's art, illustrating the adaptability of various forms of the Lundell motor to printing office work. Valuable data from tests are given to show the saving in power loss over belting and shafting. Also catalogue of the Lundell fan motors, another handsome piece of typography.

Almy Water-Tube Boiler Co., Providence, R. I., U. S. A.=A general catalogue of the Almy water-tube boilers, giving dimensions and illustrations of the various styles, and also comparative evaporative tests made by well-known experts.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Instructive pamphlet on friction and lubrication, showing the special value of flake graphite as a lubricant.

Chicago Mining Machine Co., Chicago, Ill., U. S. A.=A valuable pamphlet describing machines for the recovery of gold from placer gravels and particularly applicable to placers having no dump and a very small water supply. The characteristics of gold deposits and the methods of extracting gold are treated in a clear and scientific manner.

Henry E. Pridmore, Chicago, Ill., U. S. A.= A descriptive pamphlet of the Pridmore molding machines, with photographs of the machines and an account of the Pridmore method of molding by machinery in the foundry.

The Charles B. King Co., Detroit, Mich., U. S. A.=Catalogue of the King gasoline engines, especially showing their adaptability to marine launches.

Jarvis Manufacturing Co., Chicago, Ill., U. S. A.=A pamphlet illustrating the Jarvis sliding grate, and showing its adaptability to locomotive, marine, and stationary boilers. A series of successive views show the manner in which the sections rock and slide between each other.

Philadelphia Machine Tool Co., Philadelphia, Pa., U. S. A.=Neat little pocket catalogue of special machinery for working sheet metal, including punching, embossing, and drawing presses, and other special tools.

U. S. Wind Engine & Pump Co., Batavia, Ill., U. S. A.=Handsome catalogue devoted to railway water supply, with description of tanks, wind engines, pumps and connections.

The Bucyrus Company, South Milwaukee, Wis., U. S. A.=Catalogue Part VII. Placer mining machines. A handsomely illustrated catalogue of the powerful mining dredges for use in placer work, built by this well-known company, with much important and valuable descriptive matter relating to this growing line of work. Placer mining shovels for dry work are also shown. An important and valuable catalogue.

Baldwin Locomotive Works. Burnham, Williams & Co., Philadelphia, Pa., U. S. A.=Record of recent construction. Successive illustrated pamphlets, giving photographs and specifications of current work as completed for various railroad companies. Four parts received to date, forming instructive exhibits of the products of the establishment.

William H. Bryan and Henry H. Humphrey, St. Louis, Mo., U. S. A.=Pocket catalogue of references to clients for whom mechanical and electrical engineering work has been done, showing the extent and character of business undertaken.

Boston Belting Company, Boston, Mass., U. S. A.=Special circular of "Excelsior" gasket tubing, and sample of proprietary label by which it is identified.

The W. J. Clark Co., Salem, Ohio, U. S. A.= Illustrated Catalogue and Price List No. 22. A very full and complete catalogue of the "Salem" elevator buckets and other elevating and conveying specialties.

Chas. A. Schieren & Co. New York.=Big Belts. Pamphlet folder, containing lists of large leather belts sold for use in various parts of the world. Also, "Dixie Belt Leather," a handsomely illustrated pamphlet describing the firm's tannery at Bristol, Tenn., U. S. A.

The John F. Byers Machine Co., Ravenna, Ohio, U. S. A.=Extensive catalogue of portable and semi-portable steam hoisting engines, derricks and similar appliances for use of contractors and quarrymen. A useful catalogue for preservation and reference.

B. T. Sturtevant Co., Boston, Mass., U. S. A. Sturtevant Engineering Co., London.=Illustrated catalogue of the Sturtevant engines for electric light plants and general high-grade work. A beautiful specimen of typography, containing much useful information about these standard engines, making it a desirable reference catalogue.

Illinois Steel Company, Chicago, Ill., U. S. A. =Pamphlet catalogue describing the process of the manufacture of mineral wool from furnace slag, and showing its applications for insulation in cold storage, and as a filling material in building construction.

The Reeves Pulley Co., Columbus, Indiana, U. S. A.=Catalogue B, describing and illustrating the Reeves wood-split pulley clutch with cipher code, and price list of Reeves patent clutch pulleys.

The Winton Motor Carriage Co., Cleveland, Ohio, U. S. A.=Descriptive catalogue of handsome motor carriages, operated by hydrocarbon motor.

Houston, Stanwood & Gamble, Cincinnati, Ohio, U. S. A.=Pocket catalogue of H–S–G plain slide valve engines, setting forth the advantages of this type when properly built and intelligently used.

Lee-Penberthy Mfg. Co., Detroit, Mich., U. S. A.=Manual of useful and valuable information such as discount tables, pipe tables, railroad distances, &c., convenient for users, sellers, and manufacturers of steam goods and kindred lines. A most useful and convenient pocket manual, containing a great amount of valuable information condensed into a compact and convenient form. Much of the matter is based upon exhaustive tests, and the whole forms a book which should be in the hands of every working engineer.